This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Library
of the
University of Wisconsin

COLONIAL BRICK RESIDENCE AT HIGHLAND PARK, ILLINOIS

Carpentry *and* Contracting

A Practical Reference Work on

CARPENTRY, BUILDING SUPERINTENDENCE, CONTRACTING, SPECIFICATIONS, ESTIMATING, BUILDING LAWS AND CODE, UNDERWRITERS' REQUIREMENTS, HEATING, VENTILATION, PIPE FITTING, PLUMBING, ARCHITECTURAL DRAWING, BLUEPRINT READING, ETC.

Prepared by a Staff of

ARCHITECTS, CARPENTERS, CONTRACTORS, AND BUILDING EXPERTS OF THE HIGHEST PROFESSIONAL STANDING

Illustrated with over Fifteen Hundred Illustrations

FIVE VOLUMES

AMERICAN TECHNICAL SOCIETY
CHICAGO
1919

Copyright 1910, 1919

BY

AMERICAN TECHNICAL SOCIETY

Copyrighted in Great Britain

All Rights Reserved

224868 SF
APR 29 1919 .AM3
.2
5

Authors and Collaborators

FRED T. HODGSON
Architect and Editor
Member, Ontario Association of Architects
Author of "Modern Carpentry," "Architectural Drawing, Self-Taught," "The Steel Square," "Modern Estimator," etc.

H. V. VON HOLST, A.B., S.B.
Architect, Chicago
Member, American Institute of Architects

FRANK A. BOURNE, S.M.
Architect
Fellow, Boston Society of Architects
Associate, American Institute of Architects

DANA PIERCE, B.A.
Vice-President, Underwriters' Laboratories, Inc.

EDWARD NICHOLS
Architect, Boston, Massachusetts

GILBERT TOWNSEND, S.B.
With Ross & MacDonald, Montreal

FREDERICK E. TURNEAURE, C.E., Dr.Eng.
Dean, College of Mechanics and Engineering, University of Wisconsin
American Society of Civil Engineers

CHARLES L. HUBBARD, S.B., M.E.
Consulting Engineer on Heating, Ventilating, Lighting, and Power
Formerly with S. Homer Woodbridge Company

GLENN M. HOBBS, Ph.D.
Secretary and Educational Director, American School of Correspondence
Formerly Member of Physics Faculty, University of Chicago
American Physical Society

FRANK CHOUTEAU BROWN
Architect, Boston
Author of "Letters and Lettering"

ERVIN KENISON, S.B.
Associate Professor of Drawing and Descriptive Geometry, Massachusetts Institute of Technology

Authors and Collaborators—Continued

HOWARD P. FAIRFIELD
Assistant Professor of Machine Construction, Worcester Polytechnic Institute
American Society of Mechanical Engineers

F. W. FITZPATRICK
Consulting Architect (formerly of U. S. Service)
Executive Officer, International Society of State and Municipal Building Commissioners and Inspectors, etc.

ELIOT N. JONES, A.B., LL.B.
Of the Boston Bar

EDWARD B. WAITE
Formerly Dean and Head, Consulting Department, American School of Correspondence
American Society of Mechanical Engineers

ALVAH HORTON SABIN, C.E.
Lecturer, New York University
Author of "Technology of Paint and Varnish," etc.
American Society of Mechanical Engineers

MORRIS WILLIAMS
Writer and Expert on Carpentry and Building

ARTHUR BATEMAN
Head, Sanitary Department, American School of Correspondence
American Society of Sanitary Engineers
British Institute of Sanitary Engineers
Registered Master Plumber

OTIS W. RICHARDSON, LL.B.
Of the Boston Bar

JAMES C. PLANT
Superintendent of Computing Division, Office of Supervising Architect, Washington, D. C.

WILLIAM G. SNOW, S.B.
Steam Heating Specialist
Author of "Furnace Heating"; Joint Author of "Ventilation of Buildings"
American Society of Mechanical Engineers

WILLIAM NEUBECKER
Instructor, Sheet Metal Department, New York Trade School

JESSIE M. SHEPHERD, A.B.
Head, Publication Department, American Technical Society

Authorities Consulted

THE editors have freely consulted the standard technical literature of America and Europe in the preparation of these volumes. They desire to express their indebtedness particularly to the following eminent authorities whose well-known works should be in the library of everyone connected with building.

Grateful acknowledgment is here made also for the invaluable cooperation of the foremost architects, engineers, and builders in making these volumes thoroughly representative of the very best and latest practice in the design and construction of buildings; also for valuable drawings and data, suggestions, criticisms, and other courtesies.

J. B. JOHNSON, C.E.
Formerly Dean, College of Mechanics and Engineering, University of Wisconsin
Author of "Engineering Contracts and Specifications," "Materials of Construction"; Joint Author of "Theory and Practice in the Designing of Modern Framed Structures"

JOHN CASSAN WAIT, M.C.E., LL.B.
Counselor-at-Law and Consulting Engineer; Formerly Assistant Professor of Engineering at Harvard University
Author of "Engineering and Architectural Jurisprudence"

T. M. CLARK
Fellow of the American Institute of Architects
Author of "Building Superintendence," "Architect, Builder, and Owner before the Law"

FRANK E. KIDDER, C.E., Ph.D.
Consulting Architect and Structural Engineer; Fellow of the American Institute of Architects
Author of "Architects' and Builders' Pocket Book," "Building Construction and Superintendence; Part I, Masons' Work; Part II, Carpenters' Work; Part III, Trussed Roofs and Roof Trusses," "Churches and Chapels"

N. CLIFFORD RICKER, D.Arch.
Emeritus Professor of Architecture, University of Illinois
Author of "Simplified Formulas for Floors and Roofs"

W. R. WARE
Formerly Professor of Architecture, Columbia University
Author of "Modern Perspective"

Authorities Consulted—Continued

CLARENCE A. MARTIN
Professor of Architecture, Cornell University
Author of "Details of Building Construction"

FRANK N. SNYDER
Architect
Author of "Building Details"

CHARLES H. SNOW
Author of "The Principal Species of Wood, Their Characteristic Properties"

OWEN B. MAGINNIS
Author of "How to Frame a House, or House and Roof Framing"

HALBERT P. GILLETTE, C.E.
Author of "Handbook of Cost Data for Contractors and Engineers"

OLIVER COLEMAN
Author of "Successful Houses"

CHAS. E. GREENE, A.M., C.E.
Formerly Professor of Civil Engineering, University of Michigan
Author of "Structural Mechanics"

LOUIS de C. BERG
Author of "Safe Building"

FRANK R. WALKER
Author of "The Building Estimator's Reference Book"

IRA O. BAKER
Emeritus Professor of Civil Engineering, University of Illinois
Author of "A Treatise on Masonry Construction"

GEORGE P. MERRILL
Author of "Stones for Building and Decoration"

FREDERICK W. TAYLOR, M.E., and SANFORD E. THOMPSON, S.B., C.E.
Joint Authors of "A Treatise on Concrete, Plain and Reinforced"

Authorities Consulted—Continued

A. W. BUEL and C. S. HILL
Joint Authors of "Reinforced Concrete"

NEWTON HARRISON, E.E.
Author of "Electric Wiring, Diagrams, and Switchboards"

FREDERICK E. TURNEAURE, C.E., Dr.Eng.
Dean of the College of Engineering and Professor of Engineering, University of Wisconsin
Joint Author of "Public Water Supplies," "Theory and Practice of Modern Framed Structures," "Principles of Reinforced Concrete Construction"

J. R. CRAVATH and V. R. LANSINGH
Joint Authors of "Practical Illumination"

JOSEPH KENDALL FREITAG, B.S., C.E.
American Society of Civil Engineers
Author of "Architectural Engineering," "Fireproofing of Steel Buildings," "Fire Prevention and Fire Protection"

WILLIAM H. BIRKMIRE, C.E.
Author of "Planning and Construction of High Office Buildings," "Architectural Iron and Steel, and Its Application in the Construction of Buildings," "Compound Riveted Girders," "Skeleton Structures," etc.

EVERETT U. CROSBY and HENRY A. FISKE
Joint Authors of "Handbook of Fire Protection for Improved Risk"

CARNEGIE STEEL COMPANY
Authors of "Pocket Companion, Containing Useful Information and Tables Appertaining to the Use of Steel"

ALPHA PIERCE JAMISON, M.E.
Assistant Professor of Mechanical Drawing, Purdue University
Author of "Advanced Mechanical Drawing"

H. G. RITCHEY
Superintendent of Construction, U. S. Public Buildings
Author of "A Handbook for Superintendents of Construction, Architects, Builders, and Building Inspectors"

Authorities Consulted—Continued

HENRY McGOODWIN
Author of "Architectural Shades and Shadows"

VIGNOLA
Author of "The Five Orders of Architecture," American Edition by Professor Ware

CHAS. D. MAGINNIS
Author of "Pen Drawing, An Illustrated Treatise"

FRANZ S. MEYER
Professor in the School of Industrial Art, Karlsruhe
Author of "Handbook of Ornament," American Edition

RUSSELL STURGIS
Author of "A Dictionary of Architecture and Building," "How to Judge Architecture"

A. D. F. HAMLIN, A.M.
Professor of Architecture, Columbia University
Author of "A Textbook of the History of Architecture"

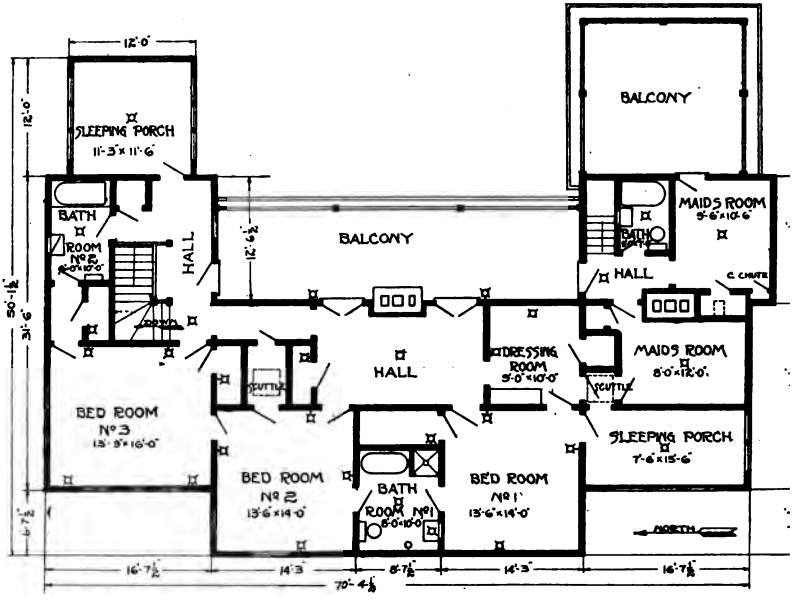
RALPH ADAMS CRAM, Litt.D.
Professor of Architecture, Massachusetts Institute of Technology
Author of "Church Building"

C. H. MOORE
Author of "Development and Character of Gothic Architecture"

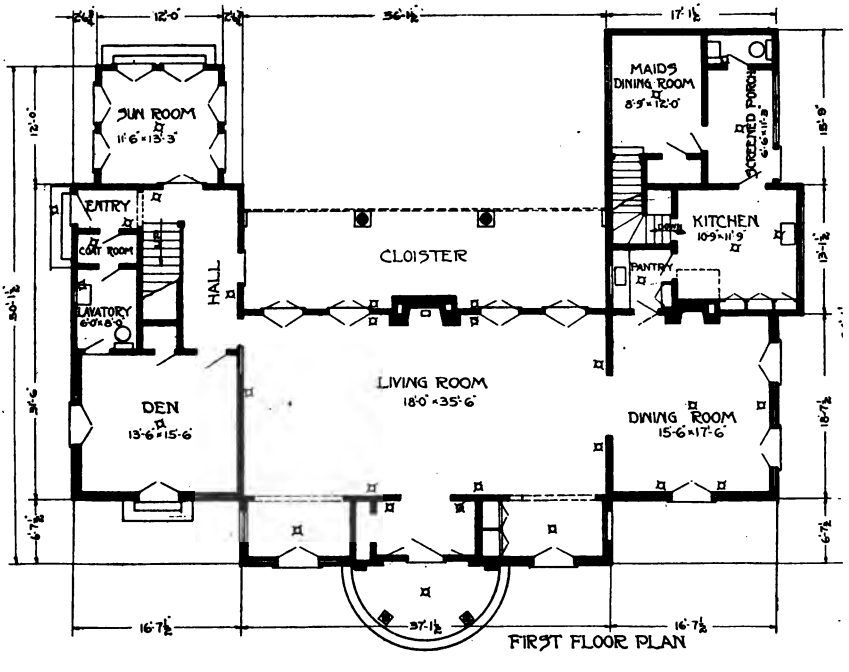
ROLLA C. CARPENTER, C.E., M.M.E.
Professor of Experimental Engineering, Cornell University
Author of "Heating and Ventilating Buildings"

WILLIAM PAUL GERHARD
Author of "A Guide to Sanitary House Inspection," "Sanitation of Public Buildings," "Theater Fires and Panics," "Water Supply, Sewerage, and Plumbing of Modern City Buildings"

I. J. COSGROVE
Author of "Principles and Practice of Plumbing"



SECOND FLOOR PLAN



FIRST FLOOR PLAN

FLOOR PLANS OF C. C. GATES RESIDENCE, PASADENA, CALIFORNIA

George A. Clark, Designer, Pasadena, California

For exterior view see reverse side of page

GARDEN FRONT OF C. C. GATES RESIDENCE, PASADENA, CALIFORNIA
George A. Clark, Designer, Pasadena, California
For plans see reverse side of page

Foreword

THE building industry is today one of our most important and permanent institutions. Every new family unit must find a dwelling place, every new industry must be properly housed in order to do its work without hindrance from the weather. But with this development have come complications never dreamed of by our forefathers. In former years, every carpenter was a builder and he did very well for he confined himself to simple jobs—in fact there were none but simple jobs. There were then no complications with plumbing, gas and water fitting, heating, electric wiring, etc. There were no city ordinances to comply with, no building restrictions to be acquainted with. The laws regarding property rights, labor, etc., were simple, and the question of material was not as complicated.

¶ Today, however, all these things must be considered even if a building is to be erected in a comparatively small town. Most villages have some kind of water system, electricity and gas are almost everywhere, and the house builder demands more artistry in the design and more comforts within the home. Year by year, the practices of our best builders are becoming more standardized, more refined, and more practical. New methods, new tools, and labor-saving ideas are being evolved as new problems of construction present themselves. It therefore behooves every contractor and builder to keep in touch with the progress of the art by possessing handbooks and reference works which will show him the way.

¶ In the preparation of these volumes, the aim has been to create not merely a work which will appeal to the trained expert but one that will commend itself to the beginner and to the self-taught practical man by broadening his knowledge beyond the limits of his experience.

¶ Another point which has been considered is that, notwithstanding the fact that this is a day of specialists, every contractor and builder must be familiar with the specifications for the foundations, framing, interior work, heating, plumbing, wiring, and other specialties entering into the construction of the building. This information is presented in readable form and will be found adequate for the construction of buildings of moderate size. For the details of construction of large buildings of steel and concrete, readers are referred to our more comprehensive reference work entitled "Architecture, Carpentry, and Building" in ten volumes.

¶ The various sections of this work have been prepared especially for home study by acknowledged experts on the subjects and are as free from technical terms as possible. The importance of such practical subjects as Carpentry, Building Superintendence, Estimating, Steam and Hot-Water Fitting, Drainage and Venting, Blueprint Reading, etc., has been emphasized. The illustrations have been selected with care, and numerous tables and diagrams are introduced wherever possible. It is the hope of the publishers that this reference work will be found of distinct value in its field.

Table of Contents

VOLUME V

ESTIMATING . . . . . *By Edward Nichols*† **Page** *11

Prices — Profit — Percentage — Duplicate Parts—Transportation—Approximate Estimates: Estimating by the Square—Estimating by Quantities — Preparation — Definitions—Units—Wages—Excavation—Stonework—Brickwork: Chimneys, Flue Lining, Masons' Supplies, Cellar Columns, Drain Pipe—Carpentry: Board Measure, Prices of Lumber, Cost of Frame, Windows, Doors, Stairs, Finish—Hardware—Roofing—Plastering—Painting—Heating—Plumbing—Gasfitting—Electrical Work—Labor—Typical Specimen of Estimate—Schedules

CONTRACTS AND SPECIFICATIONS . *Revised by Edward Nichols* **Page** 119

Specification and Its Function—Points of Emphasis in Specification Writing—Specification Writer's Methods of Work: Outlining Main Divisions, Card Catalogues, Specification Reminder, Final Steps—Specification for Suburban Work: General Conditions, Excavation, Grading, Stonework, Brickwork, Lathing and Plastering, Metal Work, Carpentry Work, Painting, Glazing, Heating, Plumbing, Gasfitting, Vacuum Cleaner—Specifications for City Work: Preliminary Studies, Studies in Materials—Outline Specifications: General Conditions, Excavation, Masonry, Carpentry, Plastering, Painting, Varnishing, Glazing, Plumbing and Gas Piping, Heating, Cleaning Premises—Formal Contracts: Contractor's Bids, Award of Contract, General Contracts, Government Contracts, Specimen Government Contract

THE ARCHITECT IN HIS LEGAL RELATIONS . . . . . *By Eliot N. Jones and O. W. Richardson* **Page** 223

Contracts—Agency—Liens—Torts—Architect's Duties in General—Position under Building Contract: Certificates, Settlement of Disputes, Inspection, Relations to Owner, Relations to Contractor, Liability of Architect, Competitive Designs, Ownership of Plans, Compensation—Appendix: Notice to Architects, Builders, and Contractors, Notes on Standard Documents, Uniform Contract, Standard Form of Agreement between Contractor and Owner, General Provisions of Contract, Professional Practice of Architects and Schedule of Charges

BUILDING CODE . . . . . *By F. W. Fitzpatrick* **Page** 307

Organization, Administration, and Supervision of Building Department—Plans, Fees, Penalties, and Licenses—Fire Limits—Quality of Materials: Tests—Factors of Safety—Loading of Soil—Excavations—Foundations and Footings—Walls, Piers, and Partitions—Boilers, Ovens, and Heating Apparatus—Stove and Smoke Pipes—Chimneys, Flues, and Fireplaces—Mill Construction—Fireproof Construction: General Specifications, Reinforced Concrete Construction, Reinforced Terra Cotta Hollow Tile, Concrete Building Blocks, Steel and Wrought-Iron Construction—Special Building Requirements: Public Buildings, Theaters, Hotels, Plumbing, Heating, Lighting, Hoistways, Well-Holes, Stairways, Doors, Fire Appliances, Standpipes, Fire Extinguishers, Axes, Automatic Sprinklers

REVIEW QUESTIONS . . . . . **Page** 423

INDEX . . . . . **Page** 433

*For page numbers, see foot of pages.

†For professional standing of authors, see list of Authors and Collaborators at front of volume.

TWO VIEWS OF LIVING ROOM OF THE C. C. GATES RESIDENCE
George A. Clark, Designer, Pasadena, California
For other views see opposite foreword

ESTIMATING*

PART I

INTRODUCTION

The ability to estimate may be considered as the dividing line between the journeyman and the master builder for, no matter how skilful a mechanic may become, he can never "hang out his shingle" and invite patronage in his distinctive line of work unless he becomes able to make reliable estimates of material and labor to be furnished. To do this, something more than mere accuracy and quickness in figures or a mastery of mathematics is needed; the estimator must have also experience and judgment, an understanding of the more or less complicated details which go to make up a building, and a knowledge of current prices and discounts in the trade. It is the object of this text to point the way toward the acquirement of such of these essentials as may be imparted by words or figures, that is, to put in condensed form some of the common methods by which estimates are made up, and to point out some of the things which are to be avoided.

As prices of labor and materials are constantly shifting with the times and with the location of the job, the figures quoted in this work must be taken only as proportionate, to be used in comparison with known quantities and methods, and not as a basis for making actual estimates. On account of the variableness in price, it is better, in general, to make estimates on the basis of days or hours of labor and of quantities of materials, so that they may be used for comparison in future work, and to this end all estimates should be carefully labeled and filed away for future reference. This should be done whether the bids were successful or otherwise; if a bid is successful, there will arise a good opportunity to compare the estimates of cost of the different items with the actual cost of execution; if a bid

*There is no such a thing as a universal or permanent standard price for anything. Prices vary in different localities at the same time and in the same locality at different times. The estimator must therefore acquaint himself with local market conditions in every case.

fails to win the job, satisfaction and experience may be gained by noting the items which may have been priced too high or too low. This data will be of great service in preparing future estimates, especially in the comparisons between estimated and actually executed work.

GENERAL FACTORS IN ESTIMATING

Use of Catalogues and Price Lists. Catalogues and price lists of all standard articles are easily obtained and should be kept at hand, properly indexed, for ready reference, as they contain a great deal of specific information. For close figuring, however, it will not do to rely upon these prices, as the amounts of trade discounts are not always included. These vary greatly from time to time, and often there are two or more discounts—a trade discount, a cash discount, and a variation in discounts made by different merchants—all of which the contractor must be familiar with to obtain bottom prices.

Data of this sort should be carefully tabulated for constant reference, in such a form that it may be easily revised and kept, so far as possible, up-to-date.

Time and Manner of Payment. The manner and time of payments is a matter to be considered in this connection, so that the contractor can take advantage of cash discounts, which often make a great difference in the cost of certain materials.

Determination of Profit. *Lump-Sum Method.* To the actual price of labor and materials must be added the profit and this will need careful consideration. A common method is to add a lump sum to the estimated cost of labor and materials, this amount varying with locality and customer, with the probable sharpness of competition, and with the circumstances of the contractor. This is a careless method, as it leaves no means for future comparison and no certain knowledge of just what the profits of a given job are.

Percentage Method. A better way is to base the profits upon a percentage of the estimated cost. This will vary, in ordinary cases, from 10 to 15 per cent. Ten per cent is the least that should be expected on any work, and is not enough for small contracts of two or three thousand dollars, but for large work, where there is a great duplication of parts and processes, it will generally prove sufficient.

Some contractors, whose workmen are required to perform especially skilful labor, figure 15 per cent on all labor and 10 per cent on materials.

Extent of Duplication of Parts. The matter of duplication is an important factor in estimating, as a considerable saving is often made if large quantities of material, either worked or unworked, are required; this is especially true of manufactured parts, such as doors and windows, columns, balustrades, etc. Modern machines are capable of duplication with astonishing rapidity, and workmen can put together similar parts more quickly and cheaply than they can variable members.

Transportation. The distance of the work from the shop of the contractor, or from centers of manufacture, will affect the cost to a marked degree, as much time is consumed in teaming and especially in handling the material a number of times.

If communication between the works and the building site can be established by water, it will usually save considerable expense in freight and handling, with perhaps less risk of damage, and, consequently, less expense for crating and boxing. A careful study should be made of the means of transportation to each different building site from the shop, the office, and the mill, and the data kept for future reference, subject to varying rates and conditions, to change of seasons, and amounts to be transported.

Special Conditions of Each Job. These are some of the more important matters which require preliminary consideration as affecting all estimates, but they are only a small part of the real question involved, as different localities and customs require different treatment, and numerous questions will arise to confront the contractor, all of which may be successfully met by the exercise of care and judgment.

METHODS OF ESTIMATING

Estimates are formed by many and varying methods, depending upon the degree of accuracy required, the capability of the contractor, and the character of the building. A broad division may be made between approximate estimates and accurate detailed estimates, only the latter of which should be considered when it is the intention actually to carry out the work under a definite contract.

Approximate Methods. *Estimating by Cubing.* Approximate estimates are obtained with varying degrees of accuracy by several methods, the most convenient and reliable of which is the system of cubing, i.e., the cubical content of the proposed building is ascertained and multiplied by a given price per cubic foot. This rate is obtained by careful comparison of the plans and requirements with similar buildings which have been erected under conditions as nearly as possible like the conditions under which the proposed building can be erected.

Several methods are used to determine the cubical units, depending upon the size and shape of the proposed building. One method is to multiply the square feet in the plan of the building by the distance from half the depth of foundations to half the height of the walls; another system uses the distance from the bottom of the foundation, and another obtains the actual cubical contents. Any of these may be used if the data for comparison is obtained in the same way, but all are subject to important variations which experience and judgment alone will determine. For instance, if the contour of the building is very uneven, with low portions, such as porches and sheds, and high portions, such as towers and cupolas, these must either be omitted from the whole and compared separately, or a lump sum added or subtracted according to the size and elaboration of these members.

Another variation arises in the size of rooms, giving a ratio of partitions and division walls which is not constant; then, too, a large building with many duplicated parts will, of course, require a different rating from a smaller one. The method of estimating by cubing is, therefore, at best approximate, and its degree of accuracy depends largely upon the experience and judgment of the contractor. Even long experience will afford no safeguard against unusual elaboration of interior or exterior, so that cube rates can be applied only to buildings of ordinary character, and comparisons are reliable only between buildings of like description and uses, as the treatment of even the same materials will vary largely in buildings of varying uses.

The height of the building will not increase the cube rate proportionately, unless the internal voids are alike, although it is certain that the higher the building is from the ground, the more time and

expense it requires to put the material in place, to say nothing of thicker walls and necessarily heavier construction.

Estimating by the Square. A convenient method of estimating is by the square of one hundred surface feet. This is especially applicable to office buildings, schools, mills, stables, and all buildings where the floors are few in number or similar in plan. For one-story buildings the price per square is taken to include the roof, walls, floor, and foundations, but for buildings of two or more stories the price per square should be taken separately for each floor, the lower floor being priced to include the foundations and the top floor to include the roof.

This method of estimating by the square is not so accurate as estimating by cubical contents, but the results are often more convenient and adaptable, because the tabulation of the square area of the various floors may be easily reduced to terms of accommodation for public buildings or shops. For instance, a given floor area in a school house means accommodation for a certain number of pupils; in a church, a certain number of sittings; in factories for the manufacture ofstaple goods, a certain number of machines and operatives.

Estimating by Units of Accommodation. This unit of accommodation is sometimes carried further, and, by the reverse process, made the basis of another method of estimating the approximate cost of such buildings as the above mentioned, i.e., schools, churches, factories, hospitals, etc. This is also a method by comparison, the known data being supplied by previous experience or calculation, and it is often valuable as a means of determining the approximate cost of buildings necessary to accommodate a given number of individuals or machines, before any definite plans have been drawn.

All of these methods are approximate, with varying degrees of accuracy, and should never be advanced as accurate, or used as the basis of a contract, unless the contractor has had a long and varied experience and feels absolutely certain of his judgment, or unless a proper margin is added for possible variations.

Accurate Method. *Estimating by Quantities.* The only sure and correct method of estimating is by taking off the actual quantities in detail and carrying out the prices accurately, with the cost of labor, the percentage for profit, and contingencies added.

For this, accurate and complete drawings and specifications are necessary to give the absolute quantity and quality of materials and

labor. The various items are then taken off, similar portions grouped, the amount of labor estimated, and a complete and classified schedule prepared and priced at current rates; the cost of transportation, board of men, and any other contingencies noted, a percentage of profit added, and a sum total reached which should be correct if faithfully done.

This, of course, takes considerable time, but is well worth the expense and trouble if a definite contract is to be made.

Preliminary Investigations. In order to estimate to a sufficient degree of accuracy, some things other than the possession of plans and specifications are necessary. A visit to the site should be made, to ascertain the nature of the soil, the levels of the lot, the distance from railroad or wharf, the condition of the roads, and the preparation of the site necessary to receive and dispose of materials. Some knowledge should be obtained of the nature of the subsoil, the presence of ledges or water below the surface which will require especial or costly treatment, etc. Often a deposit of sand will be found upon the site which will not only save carting away the material excavated, but, if of proper quality, may be used for the work. There are many such incidental factors involved, so that a knowledge of existing conditions will be of great advantage to the estimator.

Regarding underground conditions, there is always an element of chance, as the most thorough examination will not always reveal hidden perils. The author knows of a case where a mason had contracted for the building of a sewer, and was in a fair way to make a good profit, when a narrow vein of quicksand was uncovered, to overcome which not only took away all the anticipated profit but caused a severe loss besides.

Ground water is another source of loss and it will be well for the contractor to examine his contract closely, to see to what extent he is to furnish protection from this danger, as a vein of water which may have been temporarily stopped or diverted by the operation of building, will sometimes unexpectedly make its presence known during or after the completion of the work, when it may become a source of great annoyance and expense to the contractor if he has agreed to insure a waterproof job. Numerous illustrations could be given of the danger from unforeseen causes which can at best be only partially obviated by the most careful examination.

IMPORTANT ARITHMETICAL PRINCIPLES

In order to take off a building accurately, either by quantities, square, or cube, a good knowledge of arithmetic is necessary; and, while we may assume that the reader already possesses this, it may be well to include some of the essential rules of that branch of arithmetic which is known as mensuration. This consists primarily in the science of obtaining such definite data regarding given figures or surfaces, as area, solidity, capacity, linear dimensions, and comparison with other bodies.

Definitions of Arithmetical Terms. The *area*, or superficial dimension of any figure is the measure of its surface, without regard to its thickness or any other third dimension.

The *cubical content* of any figure is the measure of its solidity, or whole capacity, and has reference to the three dimensions, length, breadth, and thickness.

If the figure is considered as hollow, then the cubical content becomes its *capacity* or capability of containing matter.

The *linear dimension* of a figure is expressed by its length in a direct line in any direction and has no regard to breadth or thickness.

Units of Measurement. The application of these dimensions is made by fixing a unit by which the figure may be compared and the required dimension obtained: thus, for calculating the area of a figure the unit is usually a square, one side of which is the unit of length; and the area becomes the square measure of the figure.

This is expressed in common terms by square inch, square foot, square yard, or any other given unit, and the measure of the surface is computed by obtaining the number of these square units which are contained in the figure, the process being called squaring.

In a similar manner the cubical contents or solidity of a figure is obtained by computing the number of cubical units which it contains, which is called cubing it.

Rules for Determination of Unknown Dimensions. Numerous rules have been framed for obtaining unknown dimensions from given dimensions. There are given below the formulas and data which should enable the student to solve most of the ordinary problems which will arise in common practice.

Measurements of Surfaces

Linear Dimensions

Circumference of circle	= *diameter* × *3.1416*
Circumference of ellipse	= (*square root of one-half the sum of the squares of the two axes*) × *3.1416*
Radius of circle	= *circumference* × *0.159155*
Radius of circle	= *square root of area* × *0.56419*
Diameter of circle	= *circumference* × *0.31831*
Side of inscribed square	= *diameter* × *0.7071*
Side of inscribed square	= *circumference* × *0.2251*
Side of equal square	= *diameter* × *0.8862*

Area

Area of circle	= *square of radius* × *3.1416*
Area of circle	= *square of diameter* × *0.7854*
Area of circle	= *square of circumference* × *0.07958*
Area of circle	= ½ *circumference* × ½ *diameter*
Area of ellipse	= *product of both diameters* × *0.7854*
Area of triangle	= *base* × ½ *altitude* (*Fig. 1*)

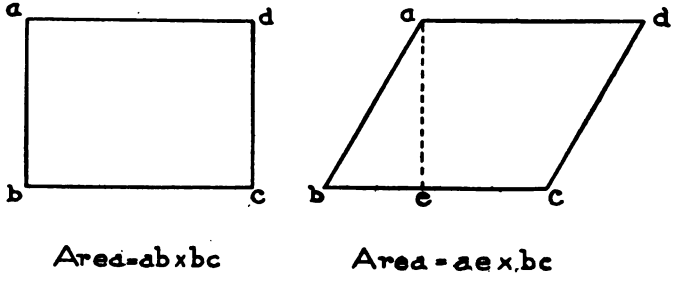


Fig. 1. Diagrams Illustrating Areas of Parallelograms

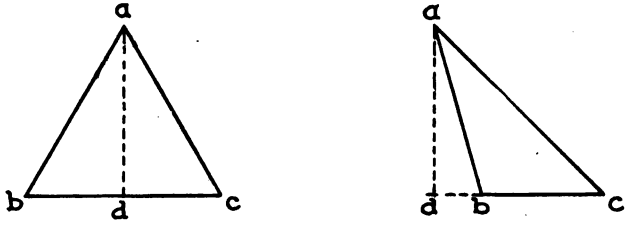
Area of parallelogram	= *length* × *breadth or perpendicular height* (*Fig. 2*)
Area of trapezoid	= *sum of parallel sides* × ½ *perpendicular distance between them* (*Fig. 3*)
Area of trapezium	= *sum of areas of triangles into which trapezium may be divided* (*Fig. 4*)
Area of regular polygon	= *length of one side* × ½ *perpendicular distance from center* × *No. of sides*
Area of irregular polygon	= *sum of areas of triangles into which polygon may be divided* (*Fig. 5*)

Area of ring included between circumferences of two concentric circles } = { *square of one diameter − square of other diameter) × 0.7854 (Fig.6)*

Measurements of Solids

Linear Dimensions

Diameter of sphere . . . . . = *square root of surface × 0.56419*



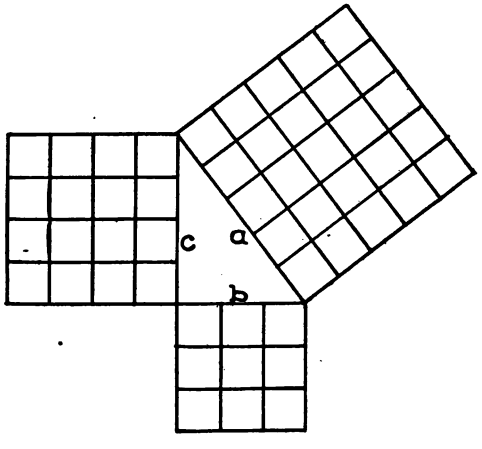
$$\text{Area} = bc \times \tfrac{1}{2} ad$$

Fig. 2. Diagrams Illustrating Areas of Triangles

Diameter of sphere . . . . . = *cube root of solidity × 1.2407*
Circumference of sphere . . . . . = *cube root of solidity × 3.8979*

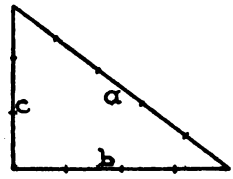
Area

Surface of sphere . . . . . = *circumference × diameter*
Surface of sphere . . . . . = *square of diameter × 3.1416*
Surface of sphere . . . . . = *square of circumference × 0.3183*



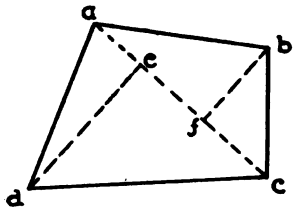
$$a = \sqrt{b^2 + c^2}$$

Fig. 3. Diagram Proof of Law of Right Triangle



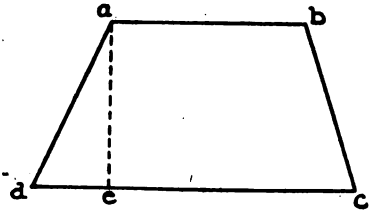
$$b = \sqrt{a^2 - c^2}$$
$$c = \sqrt{a^2 - b^2}$$

Fig. 4. Diagram of Right Triangle



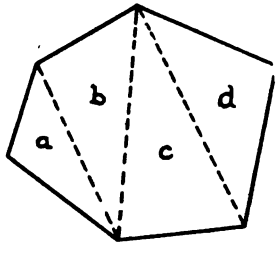
$$\text{Area} = \left(ac \times \tfrac{1}{2} bf\right) + \left(ac \times \tfrac{1}{2} de\right)$$

Fig. 5. Diagram for Finding Area of Trapesium



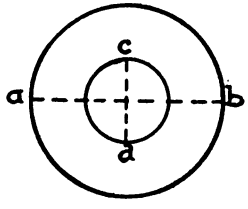
$$\text{Area} = \tfrac{1}{2} ae(ab + dc)$$

Fig. 6. Diagram for Finding Area of Trapezoid



$$\text{Area} = a + b + c + d$$

Fig. 7. Diagram for Finding Area of Irregular Polygon



$$\text{Area} = (ab)^2 - (cd)^2 \times .7854$$

Fig. 8. Diagram of Concentric Circles

Surface of cube . . . = *area of one side* × 6
Lateral surface of prism . . . . . = *perimeter of base* × *altitude*
Lateral surface of regular pyramid . . . = *perimeter of base* × ½ *slant height* (*Fig. 7*)
Lateral surface of frustrum of regular pyramid = *sum of perimeters of two ends* × ½ *slant height* (*Fig. 8*)

Solidity or Capacity

Solid contents of sphere . . . . . = *surface* × ⅙ *diameter*
Solid contents of sphere . . . . . = *cube of diameter* × 0.5236

Solid contents of cone or pyramid . . . . . = *area of base* × ⅓ *altitude*
Solid contents of cylinder . . . . . = *area of base* × *height*

TABLE I

Areas of Circles

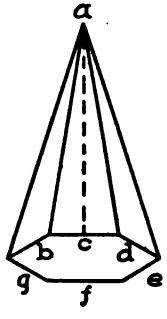
Diameter (in.)	Area (sq. in.)	Diameter (in.)	Area (sq. in.)	Diameter (in.)	Area (sq. in.)	Diameter (in.)	Area (sq. in.)
1/8	0.0123	10	78.54	30	706.86	65	3318.3
1/4	0.0491	1/2	86.59	31	754.76	66	3421.2
3/8	0.1104	11	95.03	32	804.24	67	3525.6
1/2	0.1963	1/2	103.86	33	855.30	68	3631.6
5/8	0.3067	12	113.09	34	907.92	69	3739.2
3/4	0.4417	1/2	122.71	35	962.11	70	3848.4
7/8	0.6013	13	132.73	36	1017.8	71	3959.2
1	0.7854	1/2	143.13	37	1075.2	72	4071.5
1/8	0.9940	14	153.93	38	1134.1	73	4185.3
1/4	1.227	1/2	165.13	39	1194.5	74	4300.8
3/8	1.484	15	176.71	40	1256.6	75	4417.8
1/2	1.767	1/2	188.69	41	1320.2	76	4536.4
5/8	2.073	16	201.06	42	1385.4	77	4656.0
3/4	2.405	1/2	213.82	43	1452.2	78	4778.3
7/8	2.761	17	226.98	44	1520.5	79	4901.6
2	3.141	1/2	240.52	45	1590.4	80	5026.5
1/4	3.976	18	254.46	46	1661.9	81	5153.0
1/2	4.908	1/2	268.80	47	1734.9	82	5281.0
3/4	5.939	19	283.52	48	1809.5	83	5410.6
3	7.068	1/2	298.64	49	1885.7	84	5541.7
1/4	8.295	20	314.16	50	1963.5	85	5674.5
1/2	9.621	1/2	330.06	51	2042.8	86	5808.8
3/4	11.044	21	346.36	52	2123.7	87	5944.6
4	12.566	1/2	363.05	53	2206.1	88	6082.1
1/2	15.904	22	380.13	54	2290.2	89	6221.1
5	19.635	1/2	397.60	55	2375.8	90	6361.7
1/2	23.758	23	415.47	56	2463.0	91	6503.8
6	28.274	1/2	433.73	57	2551.7	92	6647.6
1/2	33.183	24	452.39	58	2642.0	93	6792.9
7	38.484	1/2	471.43	59	2733.9	94	6939.7
1/2	44.178	25	490.87	60	2827.4	95	7088.2
8	50.265	26	530.93	61	2922.4	96	7238.2
1/2	56.745	27	572.55	62	3019.0	97	7389.8
9	63.617	28	615.75	63	3117.2	98	7542.9
1/2	70.882	29	660.52	64	3216.9	99	7697.7

For the convenience of the worker, there are tabulated in Table I the areas of circles with diameters varying from 1/8 inch to 99 inches.

The following rules are given for solving somewhat more complicated problems. The multipliers tabulated in Table II for the determination of measurements of polygons are the results of mathematical computations too elaborate to be repeated here.

It is also necessary at times to find an unknown dimension from one or more given dimensions. The following rules are given for the cases most commonly used by the estimator.

1. To find the hypothenuse of a right-angled triangle when the base and perpendicular are known:



$$\text{Lateral Area} = \frac{1}{2}\, ac \times (b+c+d+e+f+g)$$

Fig. 9. Diagram for Finding Lateral Area of Regular Pyramid

Add together the squares of the known sides and extract the square root of the sum (Fig. 9).

2. To find one side of a right-angled triangle when the hypothenuse and other side are known:

From the square of the hypothenuse subtract the square of the given side, and extract the square root of the remainder (Fig. 10).

3. To find the area of a regular polygon when the length of one side only is given:

Multiply the square of the side by the number opposite the polygon in Column A, Table II.

4. To find the radius of a circumscribing circle when the length of one side only is given:

Multiply the length of the side given by the number opposite the name of the polygon in Column B, Table II.

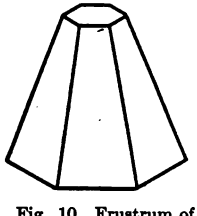


Fig. 10. Frustrum of Pyramid

5. To find the length of side of a polygon that is contained in a given circle, when the radius of the circle is known:

Multiply the radius of the circle by the number opposite the name of the polygon in Column C, Table II.

6. To find the radius of a circle that can be inscribed in a given polygon when the length of the side is given:

TABLE II

Table of Multiples to Compute Measurements of Regular Polygons, the Side of the Polygon Being Unity

Name of Polygon	No. of Sides	A Area	B Radius of Circumscribing Circle	C Length of the Side	D Radius of Inscribed Circle
Triangle	3	0.433013	0.5773	1.732	0.2887
Tetragon	4	1.	0.7071	1.4142	0.5
Pentagon	5	1.720477	0.8506	1.1756	0.6882
Hexagon	6	2.598076	1.	1.	0.866
Heptagon	7	3.633912	1.1524	0.8677	1.0383
Octagon	8	4.828427	1.3066	0.7653	1.2071
Nonagon	9	6.181824	1.4619	0.684	1.3737
Decagon	10	7.694209	1.618	0.618	1.5383
Undecagon	11	9.36564	1.7747	0.5634	1.7028
Dodecagon	12	11.196152	1.9319	0.5176	1.866

Multiply the length of a side by the number opposite the name of the polygon in Column D, Table II.

COMPILATION OF ESTIMATES

We will now take up one by one the various items which the estimator must consider in making his calculations. We will consider both quantities and prices, endeavoring to suggest all the different aspects of the work that must be taken into account in making an accurate, fair, and profitable estimate. As labor is one item in every operation, the general question of wages should be first investigated.

SCALE OF WAGES

The item of cost of labor, on construction of any kind, is at best a variable quantity, dependent to a large degree upon competition, demand, and labor organization.

The cost of labor is steadily on the increase, while the hours of labor are steadily decreasing. The tendency in both directions operates to a certain degree to lessen the effective power of labor, so that the amount of work done in a day is not what it represented a few years ago.

The various schedules given below are based upon the current price of labor in Boston, Massachusetts, in 1916, but on account of the variations in labor in different parts of the country, these prices

can be used only as approximate figures. Blank spaces are left in these columns so that the student or contractor can fill in local or varying prices of labor.

	1916	1922
Carpenters	$4.56	6.40
Stone masons	5.20	8.00
Brick masons	5.20	8.00
Hod carriers	3.60	
Plasterers	5.60	8.00
Plasterers' helpers	2.80	
Lathers	5.20	8.00
Quarrymen (9-hour day)	3.00	
Stone cutters	4.50	
Tile setters	5.50	
Cement finishers	5.00	7.20
Roofers	4.80	
Roofers' helpers	3.50	
Steamfitters	5.00	7.60
Steamfitters' helpers	2.50	
Plumbers	5.20	9.60
Gasfitters	4.80	
Gasfitters' helpers	2.50	
Electricians	5.00	7.20
Painters	4.40	7.20
Iron workers	5.00	
Laborers	2.56	

EXCAVATION

Quantities. Many considerations, seen and unforeseen, enter into the cost of excavations, as the unforeseen conditions can, at best, be only judged of, it is the more important that known circumstances should be carefully considered. Among these may be mentioned the varying kinds of soil and rock, the depth to which the excavation can be carried without shoring, the distance to which the excavated material is to be carried, and whether pumping or bailing will be necessary. Material excavated to a depth of six feet can be thrown to the surface, but below this depth a stage will be necessary, or else it must be carted or wheeled out.

In taking off quantities for excavation, work in trenches should be kept separate from large areas, as the lack of room for working in the trenches increases the cost.

Where the nature of the soil is uncertain, borings should be made or test pits dug, not only to determine the character of the material, but also to determine the depth at which hardpan is to be found. This is specially necessary when the specifications call for the foundations of any structure to be carried to hardpan, without reference to the drawings, or when no definite depth of footing is shown.

In the absence of full instructions, it is best to figure on excavating a foot outside of all walls or footings, to give ample working room; and trenches for pipes, etc., should be enough wider than the pipe to allow of working all around. Hollows should be made where hubs rest, in order to give a full bearing for the pipe.

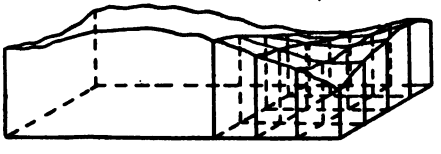


Fig. 11. Division of Plot.

In taking quantities in irregular ground, the plot should be divided into a number of definite squares and the contents of each square taken separately, Fig. 11.

Cost of Excavating. The cost of excavating varies in different localities and under differing conditions, no two cases agreeing in details or in execution. The governing factors are experience and judgment. Excavating is usually priced by the cubic yard and averages about as follows:

Picking—12 cu. yd. per day at $2.56	$0.23
Throwing out—12 cu. yd. per day at $2.56	.23
Wheeling 50 ft.	.10
Total	$0.56

Excavations in clay or very hard soil may cost from 60 cents to $1.00, while rock excavations cost from $2.00 to $10.00, or more, according to the nature and position of the rock. Refilling and packing around walls costs usually from one-quarter to one-half of the price of earth excavations. Excavation of sand or loose gravel, which can be done by means of a horse scraper, costs 30 cents per cubic yard.

Cost of Piling. The cost of piling varies with the nature of the soil and the length of pile necessary. If a 30-foot pile is taken as an average length, then piles 30 feet long, driven and cut off level to receive footings, will cost from $4.50 to $6.00 each.

Concrete piles, either driven or molded in place, will cost from $1.00 to $1.65 per lineal foot.

STONEWORK

Stone walls are figured either by the perch or the cubic yard.

In taking off a stone foundation, it is customary to take the corners twice: that is, each different face of the wall is measured from out to out, thus doubling the corners. This makes up for the extra labor of laying up the corners.

Rubble. The cost of a perch of rubble foundations laid in one-half cement mortar, 1 to 3, may be taken as follows:

1 perch stone	$1.25
¼ barrel cement, at $2.10	.52
¼ barrel lime at $1.20	.30
⅛ load sand at $1.80	.30
⅓ day, mason, at $5.20	1.73
¼ day, laborer, at $2.80	.70
Total	$4.80

A perch of rubble wall laid in Portland cement mortar, 1 to 3, costs:

1 perch stone	$1.25
½ barrel Portland cement at $2.10	1.05
⅛ load sand, at $1.80	.30
⅓ day, mason, at $5.20	1.73
⅓ day, laborer, at $2.80	.70
Total	$5.03

Cut Stone. Cut stonework is figured by the cubic foot, the prices differing according to the amount of labor involved in the cutting, and the latter depends somewhat upon the nature of the stone, a hard stone being more expensive to prepare than a soft one. The principal kinds of stone used in building are granite, limestone, sandstone, marble, and bluestone.

Granite. Granite is one of the hardest stones to quarry and prepare, and, on account of its cost it is not so extensively used as

limestone or marble. Granite in rough blocks from the quarry costs from 45 to 60 cents a cubic foot, and the cutting of beds and joints costs 25 cents for each square foot of surface treated. Pitching off the face to a line with rockface costs 25 cents per square foot, while hammering in 8-cut work costs 70 cents per square foot. Quincy granite costs, in the rough, about double this, or $1.20 per cubic foot; the cutting will cost one-third more.

This data may be tabulated as follows:

Granite, in rough blocks at quarry, per cu. ft.	$0.60
Cutting for beds and joints, per sq. ft.	.25
Rockface, per sq. ft.	.25
8-cut work, per sq. ft.	.70

Hence the facing of an average wall with 8 inches of granite, if the stones are about 2 by 3 feet, or 6 square feet in each block, will cost as follows:

Stock, 4 cu. ft., at $0.60	$2.40
Beds and end joints, 2⅔ sq. ft. at $0.25	.67
Rockface, 6 sq. ft., at $0.25	1.50
Total	$4.57
Cost per sq. ft.	.76⅛

If the stone were finished in 8-cut work, the cost of finishing the surface would be 70 cents a square foot instead of 25 cents, an increase of 45 cents, making the total cost about $1.21 a square foot.

Limestone. Limestone is used to a large extent, especially in conjunction with brick, for trimmings for various kinds of buildings. Indiana limestone costs at the quarry about 30 cents a cubic foot. Lake Superior redstone costs 35 cents; Ohio sandstone, 55 cents; In estimating, about 20 per cent should be added for waste, 5 per cent for quarry waste, and 15 per cent for cutting waste.

***Pr ces Vary with the Different Shapes Cut, but They Will Be Found to Average about as Follows:**

Water table, 8 × 12 in., per linear ft.	$1.50
Steps, 7 × 14 in., without nosing, per linear ft.	1.50
Steps, 7 × 14 in. with nosing, per linear ft.	2.50
Door sills, 8 × 12 in., per linear ft.	1.25

* These prices are based on an average freight charge of $0.50 per cu. ft.

Window sills, 5 × 12 in., per linear ft	$1.00
Window sills, 5 × 8 in., per linear ft	.75
Window caps, 4 × 10 in., per linear ft	.70
Window caps, 8 × 12 in., per linear ft	1.00
Wall coping, 5 × 20 in., per linear ft	1.50
Platforms and large slabs, 6 in. thick, per sq. ft	2.00

A common use of limestone is in the form of window sets, consisting of a flat arch in three pieces with keystone, and a light sill, Fig. 12. The rise of these caps is about 10 inches, and the rise of the sill 5 inches. These sets for an average sized window, say with a 4-foot opening, will cost for a 4-inch reveal $10, and for an 8-inch reveal, $15.

Sandstone. The cost of dressed sandstone is about 10 per cent more than that of limestone.

Setting Granite, Limestone, and Sandstone. The cost of setting cut stone may be taken at 15 cents a running foot for window trimmings and ashlar work, and 25 cents for platforms, water table, steps, etc. Trimming and fitting at the building will cost about 10 cents per cubic foot.

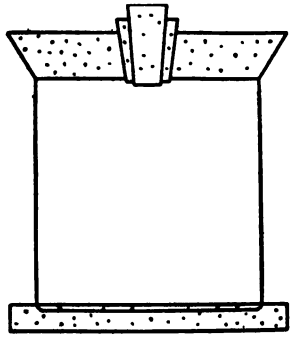


Fig. 12. Limestone Window Set

The foregoing prices are based upon quarrymen's wages at $3.00 per day, and stonecutters' wages at $4.50 per day. Much of the cutting and finishing of stone is done by machinery, so that the question of wages does not enter into the preparation of the stock so largely as in many other branches.

Marble. A more expensive stone to use is marble, which can be obtained in a variety of colors, in different parts of the country. The price of marble differs in different localities but for general purposes it may be taken as about double the figures which we have quoted for limestone.

Bluestone. In the East, bluestone is used mainly for flagging, copings, etc., but in the central and western sections it is used to a considerable extent for building. The price of bluestone flagging 3 inches thick with trimmed joints and face planed and dressed, is 65 cents a square foot; with natural face, from 35 cents to 45 cents.

Bluestone ashlar, 8 inches thick with natural face and dressed joints, costs $1.00 per square foot, and 20 cents a square foot for setting.

Seam-Faced Granite. In some localities granite, lying in upturned strata with open weathered seams, is to be obtained, Fig. 13. This is used for facing walls in ashlar work, being set on edge in the

Fig. 13. Seam-Faced Granite Wall

wall with the seam face showing; it costs in place, 4-inch to 8-inch thick, from 60 cents to 75 cents a superficial foot.

BRICKWORK

Quantities. Brickwork is usually estimated by the thousand bricks, but it is sometimes priced by the cubic foot, reckoning 40 cubic feet to a thousand brick. A mason in one day will lay from 800 to 1,000 common bricks, or 300 to 400 face bricks.

The number of bricks in a wall may be found by multiplying the superficial area by $7\frac{1}{2}$ for each 4 inches of the thickness of the wall. Openings of the size of ordinary windows are generally deducted, but very small openings will cost more to make than the deduction. An allowance for breakage should be made of 5 per cent.

Mortar. Bricks are laid in mortar made of *lime* or *cement*, according to the strength required. Lime mortar should not be used in damp situations, or where great strength is required. The difference in cost of lime and cement mortar is so little that cement mortar is generally used.

The building laws of some cities require that brickwork be laid in cement mortar for a certain part of the height.

Cement mortar makes a darker joint than lime mortar; if a white joint is required, it can be obtained, without loss of strength, by using Portland cement and lime mortar.

Cost. *Common Brick.* The cost of common brickwork by the thousand brick in various kinds of mortar, may be analyzed as follows:

IN 1:3 LIME MORTAR—	
1,000 bricks	$9.50
3 bu. lime, at $0.36	1.08
½ load of sand, at $1.80	.90
10 hours, mason, at $0.65	6.50
10 hours, tender, at $0.35	3.50
Total	$21.48
IN 1:3 ROSENDALE CEMENT MORTAR—	
1,000 bricks	$9.50
1½ bbl. Rosendale cement, at $1.25	1.88
½ load sand, at $1.80	.90
10 hours, mason, at $0.65	6.50
10 hours, tender at $0.35	3.50
Total	$22.28
IN 1:3 PORTLAND CEMENT MORTAR—	
1,000 bricks	$9.50
1¼ bbl. Portland cement, at $2.10	2.62
½ load sand, at $1.80	.90
10 hours, mason, at $0.65	6.50
10 hours, tender at $0.35	3.50
Total	$23.02

The difference in cost, it will be seen, is not great enough to be considered in a job of ordinary size, where cement mortar will give assurance of greater stability.

Cost of Face Brick. Face brick of many kinds are to be had, either plain or molded, and in a variety of colors. On ordinary face brickwork a mason with tender will lay about 300 or 400 in a day.

Face bricks cost from $25 to $50 per thousand; a good average brick can be secured for $32. This makes the price for a thousand, laid, about as follows:

1,000 face bricks	$32.00
1¼ bu. lime, at $0.36	.45
½ load fine sand, at $1.80	.90
3 days, mason, at $5.20	15.60
1½ days, tender, at $2.80	4.20
Total	$53.15

Of this sum $19.80 goes for labor and $33.35 for stock.

Enameled bricks are to be had in various colors, white and buff being the most common. These bricks cost from $75 to $100 per thousand.

CONCRETE

Concrete is used to a great extent now for footings, walls, piers, etc. The cost of concrete is not very different from the cost of stone for foundations; and if there is uncovered at the site a deposit of suitable sand and gravel, as is sometimes the case, concrete can be put in at a less price than a granite footing.

Concrete with a reinforcement of steel is used in various forms for piers, floors, and walls.

The cost of a cubic yard of concrete, using the proportion of 1:3:6, may be summarized as follows:

1 bbl. Portland cement	$2.10
3 bbl. sand	.45
6 bbl. broken stone	1.57
Concrete foreman, 2 hours, at $0.75	1.50
Laborer, 4 hours, at $0.35	1.40
Total	$7.02

Cellar concrete 3 inches thick costs from 60 cents to 75 cents per square yard in place. Concrete of Rosendale cement can be put in more cheaply; for foundation walls it costs about $6 per cubic yard, for piers $6.50 per cubic yard.

MISCELLANEOUS DATA FOR MASONRY WORK

Chimneys

Chimneys may be quickly estimated by the linear foot of height, as follows:

1 flue, 8 × 8 in., per ft.,	$1.00, with flue lining	$1.20
1 flue, 8 × 12 in., per ft.,	1.10, with flue lining	1.40
1 flue, 12 × 12 in., per ft.,	1.25, with flue lining	1.60
2 flues, 8 × 8 in., per ft.,	1.50, with flue lining	1.90
2 flues, 8 × 12 in., per ft.,	1.80, with flue lining	2.30

Flue Linings

Below are given the net prices per foot of flue linings, outside dimensions.

4½ × 8½ in.....	$0.10	8½ × 17½ in.....	$0.30
4½ × 13 in.....	.15	13 × 13 in.....	.28
8½ × 8½ in.....	.15	13 × 18 in.....	.40
8½ × 13 in.....	.22	18 × 18 in.....	.66

For openings add one-third.

Masons' Supplies

Portland cement, per bbl	$2.10
Rosendale cement, per bbl	1.25
Extra lime for skimming, per bbl	1.15
No. 1 lime for mortar, per bbl	1.05
Vermont lime, per bbl	1.20
Plaster, per 250-lb. bbl	2.00
Mortar color, red, in bbls., per lb	.01¼
Mortar color, red, in 100- or 200-lb. kegs, per lb.	.01½
Mortar color, black, per lb	.03½
Philadelphia pressed brick, for fireplaces, per M.	35.00
Firebrick, per M	35.00
Best plastering hair, per bu	.45
Mortar hods, each	1.25
Brick hods, each	1.00
10-in. mortar hoes, each	.65
Good No. 2 shovels, square point, plain back, each	1.00
Sand screens, wood leg, each	7.00
Bolted dump barrows, each	2.00
Metal corner bead, per ft	.04

Iron rim and cover, 20-in. diameter, each	$3.50
Iron rim and cover, 18-in. diameter, each	3.00
Iron rim and cover, 15-in. diameter, each	2.50
Metal lath, plain, per yd	.19
Metal lath, galvanized, per yd	.25

Cellar Columns

For cellar supports, in place of brick piers, patent pipe columns, consisting of steam pipes filled with cement, are coming into general use in many localities.

These columns cost less, and take up less room than a brick pier of equal strength. The prices, subject to a discount, are for columns of different sizes, as follows:

Diameter of Column	7-Ft. Column	8-Ft. Column	9-Ft. Column	10-Ft. Column
3 in.	$1.65	$1.90	$2.20	$2.65
3½ in.	1.90	2.20	2.65	3.15
4 in.	2.75	3.25	3.80	4.40
4½ in.	4.00	5.00	5.50	6.00
5 in.	5.00	5.85	6.65	7.55
6 in.	6.00	6.95	8.00	9.30

Earthen Drain Pipe

For sewer and cesspool connections and general drainage, earthen vitrified drainpipes are used. These are laid in cement and, if well below frost or danger of breaking, make a more durable pipe than cast iron, besides being much less costly. The weight and net price of standard vitrified pipe of various diameters are given below:

Inside Diameter	Weight (per ft.)	Price of Pipe (per ft.)	Price of Bends and Curves
2 in.	6 lb.	$0.08¾	$0.26¼
3 in.	8 lb.	.08¾	.26¼
4 in.	10 lb.	.08¾	.26¼
5 in.	12 lb.	.14	.42
6 in.	16 lb.	.14	.42
8 in.	24 lb.	.19¼	.57¾
10 in.	34 lb.	.28	.84
12 in.	45 lb.	.35	1.05
15 in.	67 lb.	.47	1.41
18 in.	86 lb.	.66½	1.99½

CARPENTRY

The carpenter-work of a building includes, in general, the skeleton or frame—if a wooden building—the floor timbers, studs of partitions and walls, rafters, the covering-in of the frame, with its exterior finish and clapboards, siding or shingles, the flooring, furring, grounds, and beads. This practically covers the constructive woodwork or carpentry proper, while to the trade of joinery belongs the outside and inside finish, windows and doors, sheathing and dado, stairs and fixtures.

In many sections the general term carpentry includes all woodworking and covering, while in others the distinction between the carpenter and the joiner is more distinctly drawn.

For the purposes of this work it will not be necessary to hold this distinction, and so for convenience the term carpentry will be used to cover all branches of woodworking.

Two distinct elements enter into the carpenter-work of any structure—material and labor—and the cost of both is subject to fluctuation to a great extent. The trend is in the direction of increased cost in varying degrees in different localities; but the state of the market in both labor and materials is never quiescent, so that any printed prices must be considered as comparative only, and must be carefully compared with local and known data before being accepted as accurate or final.

The material with which the carpenter works, consists in the main of three principal divisions—the frame, the covering, and the finish—each of which has further subdivisions, as will be noted.

Board Measure. All lumber which has not been wrought or molded, is sold by "board measure"; that is, the stock in each piece is reduced to a unit of a square foot of board one inch thick, expressed by the abbreviation B.M. Prices of lumber are usually rated by the thousand feet, so that the expression "twenty-five dollars a thousand" means twenty-five dollars for a thousand square feet of stock one inch thick.

To reduce stock of greater thickness than one inch, to its equivalent in board measure, several rules may be used. A convenient method is to divide the product of the width and thickness in inches by 12, and multiply by the length in feet.

TABLE III

Board Measure

Size of Timber (in.)	Length of Timber (ft.)											
	10	12	14	16	18	20	22	24	26	28	30	32
2 x 3	5	6	7	8	9	10	11	12	13	14	15	16
2 x 4	6⅔	8	9⅓	10⅔	12	13⅓	14⅔	16	17⅓	18⅔	20	21⅓
2 x 5	8⅓	10	11⅔	13⅓	15	16⅔	18⅓	20	21⅔	23⅓	25	26⅔
2 x 6	10	12	14	16	18	20	22	24	26	28	30	32
2 x 7	11⅔	14	16⅓	18⅔	21	23⅓	25⅔	28	30⅓	32⅔	35	37⅓
2 x 8	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔
2 x 9	15	18	21	24	27	30	33	36	39	42	45	48
2 x 10	16⅔	20	23⅓	26⅔	30	33⅓	36⅔	40	43⅓	46⅔	50	53⅓
2 x 12	20	24	28	32	36	40	44	48	52	56	60	64
2 x 14	23⅓	28	32⅔	37⅓	42	46⅔	51⅓	56	60⅔	65⅓	70	74⅔
2 x 16	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64	69⅓	74⅔	80	85⅓
3 x 4	10	12	14	16	18	20	22	24	26	28	30	32
3 x 5	12½	15	17½	20	22½	25	27½	30	32½	35	37½	40
3 x 6	15	18	21	24	27	30	33	36	39	42	45	48
3 x 7	17½	21	24½	28	31½	35	38½	42	45½	49	52½	56
3 x 8	20	24	28	32	36	40	44	48	52	56	60	64
3 x 9	22½	27	31½	36	40½	45	49½	54	58½	63	67½	72
3 x 10	25	30	35	40	45	50	55	60	65	70	75	80
3 x 12	30	36	42	48	54	60	66	72	78	84	90	96
3 x 14	35	42	49	56	63	70	77	84	91	98	105	112
3 x 16	40	48	56	64	72	80	88	96	104	112	120	128
4 x 4	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔
4 x 5	16⅔	20	23⅓	26⅔	30	33⅓	36⅔	40	43⅓	46⅔	50	53⅓
4 x 6	20	24	28	32	36	40	44	48	52	56	60	64
4 x 7	23⅓	28	32⅔	37⅓	42	46⅔	51⅓	56	60⅔	65⅓	70	74⅔
4 x 8	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64	69⅓	74⅔	80	85⅓
4 x 9	30	36	42	48	54	60	66	72	78	84	90	96
4 x 10	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80	86⅔	93⅓	100	106⅔
4 x 12	40	48	56	64	72	80	88	96	104	112	120	128
4 x 14	46⅔	56	65⅓	74⅔	84	93⅓	102⅔	112	121⅓	130⅔	140	149⅓
6 x 6	30	36	42	48	54	60	66	72	78	84	90	96
6 x 8	40	48	56	64	72	80	88	96	104	112	120	128
6 x 10	50	60	70	80	90	100	110	120	130	140	150	160
6 x 12	60	72	84	96	108	120	132	144	156	168	180	196
6 x 14	70	84	98	112	126	140	154	168	182	196	210	224
6 x 16	80	96	112	128	144	160	176	192	208	224	240	256
8 x 8	53⅓	64	74⅔	85⅓	96	106⅔	117⅓	128	138⅔	149⅓	160	170⅔
8 x 10	66⅔	80	93⅓	106⅔	120	133⅓	146⅔	160	173⅓	186⅔	200	213⅓
8 x 12	80	96	112	128	144	160	176	192	208	224	240	256
8 x 14	93⅓	112	130⅔	149⅓	168	186⅔	205⅓	224	242⅔	261⅓	280	298⅔
10 x 10	83⅓	100	116⅔	133⅓	150	166⅔	183⅓	200	216⅔	233⅓	250	266⅔
10 x 12	100	120	140	160	180	200	220	240	260	280	300	320
10 x 14	116⅔	140	163⅓	186⅔	210	233⅓	256⅔	280	303⅓	326⅔	350	373⅓
10 x 16	133⅓	160	186⅔	213⅓	240	266⅔	293⅓	320	346⅔	373⅓	400	426⅔
12 x 12	120	144	168	192	216	240	264	288	312	336	360	384
12 x 14	140	168	196	224	252	280	308	336	364	392	420	448
12 x 16	160	192	224	256	288	320	352	384	416	448	480	512
14 x 14	163⅓	196	228⅔	261⅓	294	326⅔	359⅓	392	424⅔	457⅓	490	522⅔
14 x 16	186⅔	224	261⅓	298⅔	336	373⅓	410⅔	448	485⅓	522⅔	560	597⅓

Example. How many feet, B. M., are there in a joist 2 in.×9 in., 20 ft. long?

Solution. $\frac{2\times9}{12}\times20=30$ ft. B.M.

When the sizes are fractional, or produce a product not easily divided by 12, the operation may sometimes be simplified by multiplying the length in feet by the thickness and the width in inches, and dividing the whole by 12.

Example. How many feet are there in a joist 2½ in. x 9 in., 16 ft. long?

Solution. $\frac{16\times2\frac{1}{2}\times9}{12}=30$ ft. B. M.

In Table III are tabulated the board measure for lumber of different sizes and different lengths.

Miscellaneous Prices of Lumber. At present prices, the cost of various classes of lumber, per thousand B.M., will be as follows:

FRAMING AND BOARDING LUMBER, ETC.—

Dimension spruce lumber up to 9 inches of depth	$30.00
10-inch stock	32.00
For long lengths, add per M	$2.00
Hemlock boarding	27.00
Spruce boarding	28.00
Spruce boarding matched	30.00
Spruce upper floor	45.00
Extra shingles	4.75
Clear shingles	4.50
Spruce clapboards	65.00
Siding cypress	30.00
Drop or novelty siding	55.00
Laths	4.75
*Georgia pine timbers, 12 in	42.00
*Georgia pine timbers, 14 in	55.00
*Georgia pine timbers, 16 in	60.00

FLOORING—

Georgia pine, heart face rift	$75.00
Georgia pine, common rift	50.00
Maple flooring	60.00
Quartered-oak flooring	$125.00 to 150.00

*Hard pine from the South by shipload costs about $5.00 less per M.

North Carolina pine, rift stock	$55.00
North Carolina pine, slash stock	45.00
FINISH—	
Georgia pine	$ 60.00
Cypress No. 1	70.00
Cypress No. 2	55.00
Oak, plain	100.00
Oak, quartered	125.00
Red birch	90.00
Whitewood	82.00
Ash	90.00
Elm	50.00
INSIDE DOOR FRAMES—	
2 ft. 8 in. × 6 ft. 8 in	$1.20
2 ft. 10 in. × 6 ft. 8 in	1.25
3 ft. 0 in. × 7 ft. 0 in	1.30
For transom bars add	1.00
WINDOW FRAMES—	
2½ ft. × 4½ ft	$1.10
3 ft. × 5 ft	1.25

Framing

Taking Off Quantities for Frame. In taking off the rough frame of a house for the purposes of estimating, the accurate method is to take a schedule of every piece of timber from the framing plans; but as it often happens that the estimates are asked for from the general drawings, before the framings are made, it has become the custom in many sections to extimate the cost of the walls and floors by the square of 100 superficial feet, making separate allowances for sills, girders, plates, and other large timbers.

If the estimator desires to take off the frame separately, in the absence of framing plans the following dimensions for members may be taken in the construction of an ordinary house:

Sills	from 6 in. × 6 in. to 6 in. × 10 in.
Girders	from 6 in. × 8 in. to 8 in. × 10 in.

Floor joists.....from 2 in.×8 in. to 3 in.×12 in., 16 in. on centers

Wall studding of outside frame } 2 in.×4 in., 16 in. on centers
Bearing partitions..... }

Studding of closets and light walls } 2 in.×3 in.

Plates.....4 in.×4 in. and 4 in.×6 in. (sometimes 2 in.×4 in. doubled).

Rafters.....from 2 in.×6 in. to 2 in.×12 in., 18 to 24 in. on centers

In taking off the frame, the sills and plates will of course be measured by the linear feet in the outside wall. The position of the main bearing partitions will usually give the number and location of the girders. Studs are doubled at openings and corners, and fireplaces and stair openings call for timbers of a large size, say from 6 inches to 8 inches in width.

Assuming that the joists are 16 inches on centers, the number of joists on a floor will be determined by taking three-fourths of the length of the building in feet, and adding one joist. The number of studs in the outside frame at 16 inches on centers may be found by taking three-fourths of the number of linear feet in the outside of the building, adding one stud for each corner, and one for each door and window. To this must also be added any gables or bay windows or other projections. Three-fourths of the number of linear feet of partitions will give the number of studs in the inside frame at 16 inches on centers. This allows for the doubling of studs at openings and corners. For the number of rafters in a plain gable roof, divide the length of the building by the distance of the rafters apart and add one. For the number of rafters in a hip roof, divide the whole distance around the building by the distance of the rafters apart.

Estimating Cost of Frame. In making up our estimate for the frame, we consider sills, joists, girders, etc., at the cost of a section 30 feet long, containing 90 B. M.; all other sections are estimated by the square of 100 feet, except windows and doors which are reckoned at the cost of each. We can then make our estimates for the cost of framing as follows:

SILLS—

Stock, 90 ft. B. M., 6×6 in. spruce, at $28.00 per M	$2.52
Labor of framing, at $12.00 per M	1.08
Total	$3.60
Cost per running ft	.12

FLOORS—

Joists, 2 in.×9 in., 16 in. on centers, 112½ ft. B. M., at $28.00	$3.15
Labor, per square of 100 ft	2.00
Nails, 5 lb	.15
Bridging	.50
Under floor, 100 ft. hemlock, at $27.00	2.70
Waste	.41
Labor	1.00
Nails, 5 lb. at $0.03	.15
Strapping for ceiling, 1 in.×2 in., 16 in. on centers	.60
Nails, 5 lb	.15
Labor	1.25
Upper floor, 100 ft. spruce, at $45.00	4.50
Waste, one-third stock	1.50
Labor	2.00
Nails	.15
Paper, labor, stock	.30
Total	$20.51
Rift hard pine upper floors, 100 ft. B. M. at $75.00	$7.50
Waste and matching, one-third stock	2.50
Labor	2.50
Nails	.15
Paper	.25
Total	$12.90
Approximate cost per sq. ft	$0.13
Shellac and wax, per sq. ft	.04
Total finished pine floor, per sq. ft.	$0.17

Quartered oak floor, per sq. ft.	$0.26
Shellac, per sq. ft.	.04
Total oak floor, per sq. ft.	$0.30

OUTSIDE WALLS—

Studding, 2 in.×4 in., 16 in. on centers, 50 ft. B. M., at $30.00	$1.50
Waste, one-third stock	.50
Nails	.25
Labor, per square of 100 ft.	2.00
Beads and grounds	.25
Boarding, 100 ft. hemlock, at $27.00	2.70
Waste, one-fourth stock	.41
Labor, per square of 100 ft.	1.00
Nails	.20
Total for walls boarded	$8.81

Shingles, 850 at $4.50 per M	$3.82
Paper and laying	.50
Nails	.25
Labor, per square of 100 ft.	3.00
Total	$7.57

Paper on walls, under clapboards, or shingles, per square	$0.20
Labor	.05
Total	$0.25

ROOFING—

Rafters, 2 in.×6 in., 20 in. on centers, at $28.00.	$1.68
Waste, one-fourth stock	.42
Labor	2.25
Nails	.10
Boarding	2.70
Waste	.65
Labor	1.25
Nails	.20
Total	$9.25

INSIDE STUDDING, READY FOR LATHING—

Studs, 2 in.×4 in., 16 in. on centers, 50 B. M. at $28.00	$1.40
Waste, one-third stock	.45
Nails	.15
Labor	2.00
Beads and grounds	.50
Total	$4.50

WINDOWS, IN PLACE—

Window of average size, frame	$1.25
Sashes, 3 ft.×5 ft	1.70
Blinds	1.10
Fastenings for blinds	.15
Weights, 30 lb. at $0.01¼	.45
Sash cord, 20 ft. at $0.01	.20
Sash fast	.25
Inside casings, 20 ft. at $0.03½	.70
Stop beads, 16 ft. at $0.01¾	.28
Labor, 8 hours at $0.57	4.56
Total	$10.64

Cellar window, frame	$1.50
Sash	1.20
Hardware	.15
Labor	.50
Total	$3.35

DOORS, IN PLACE—

Inside doors, 2 ft. 8 in.×6 ft. 8 in.×1½ in., pine to paint, each	$2.75
Frame	1.20
Casings	1.33
Threshold	.15
Nails	.05
Hardware	1.25
Labor, 8 hours at $0.57	4.56
Total	$11.29

Front door, common, 3 ft. 4 in. × 7 ft. 0 in. × 1⅞ in.	$5.75
Frame	4.50
Plate glass	2.50
Casings, 20 ft. at $0.04	.80
Hinges	.68
Locks and knobs	4.50
Labor	5.70
Total	$24.43
Sliding doors, complete, 2 doors, 3 ft. 0 in × 7 ft. 0 in. × 1¾ in., each	$6.00
44 ft. casings, at $0.04½	1.98
40 ft. grounds, at $0.01	.40
40 ft. stop beads at $0.02	.80
Astragal	1.00
Chafing strip	.20
Lock	4.50
Hangers and track	4.50
Sheathing pocket, 84 ft. at $0.04	3.36
Labor, 40 hours at $0.57	22.80
Total	$45.54
Cellar door, 2 ft. 8 in. × 6 ft. 8 in. × 1½ in.	$2.25
Frame	1.00
Finish, 36 ft. at $0.04½	1.62
Threshold	.15
Hardware	.85
Labor	4.00
Total	$9.87
PIAZZAS AND PORCHES—	
Shingled piazza column, 28-ft. boards at $0.02½	$0.70
11 ft. studding, at $0.03	.33
1 bunch shingles	1.12
Nails	.15
Labor	5.00
Total	$7.30
Square-cased column, 8 × 8 in.	$1.50
Labor	2.00
Erection	.75
Total	$4.25

Balustrade, of straight, square, 1⅛-in. balusters,	
top rail, 3 in.×4 in., per ft	$0.15
Bottom rail, 2 ft.×4 in., per ft	.10
Balusters, 4 to a ft	.15
Labor	.40
Total	$0.80
Ceiling, per square	
Sheathing	$5.00
Waste	1.50
Furring	1.50
Nails	.25
Labor	2.00
Total	$10.25
CONDUCTORS—	
15 ft. pipe, at $0.15	$2.25
Gooseneck and labor	.65
Erection	.50
Total	$3.40

Prices of Miscellaneous Materials

Inside Finish. Whitewood or cypress stock which has been molded costs one cent for every square inch of section one foot long, less a trade discount, which at present is 30 per cent for cypress and 20 per cent for whitewood. A 5-inch cypress casing will cost, therefore, 5 cents per foot less 30 per cent, or 3½ cents. Various other prices for inside finish are as follows:

FINISHING STOCK—	
5-in. casings	$0.03½
8-in. base	.05½
Plinth blocks, 5 in.×8 in.×1⅜ in	.05
Corner blocks, 5 in.×5 in.×1⅛ in	.07
Moldings per square of section	.00 7/10
Stock pattern stair rail, 2½ in.×2¾ in. per ft	.10
Balusters, 1⅜, each	.12
Newels, 5-in. stock pattern	5.50
Newels, 6-in. stock pattern	6.00
Plate rail and picture molding, per ft	.07

Picture molding, per ft	$0.01½ to $0.03
Stock drawer case, 3 drawers	4.75
Paneled drawer case, 5 drawers	15.00

FINISH STOCK IN PLACE—

8-in. baseboard with 2-in. molding, per running ft	.12
4-ft. wainscot of narrow sheathing, per running ft	.40
Plain wall sheathing, per sq. ft	.05
3½-in. cap for wainscot	.06
2-in. picture molding	.06
4-in. chair rail	.07
3-ft. paneled dado, per sq. ft	.35
Drawer case, 3 drawers, complete	8.00

INSIDE DOORS, 5 CROSS PANELS, IN PINE TO PAINT—

2 ft. 8 in. × 6 ft. 8 in. × 1½ in	$2.75
2 ft. 10 in. × 6 ft. 10 in. × 1½ in	3.00
3 ft. 0 in. × 7 ft. 0 in. × 1½ in	3.25

Exterior Finish. The exterior finish of a house consists, in the main, of the water table at the bottom, the belt midway, and the cornice at the top, and the finish for the porches and piazzas.

LABOR ON EXTERIOR FINISH—

Water table, 3 members, at $0.04	$0.12
Corner boards, per ft	.04
Belt, per ft	.10
Cornice, $0.03 to $0.06 per member, or per ft.	.75
Gable finish, per ft	.75

PIAZZA FINISH —

Stock pattern 5-in. turned columns, 8 ft. long	$2.50
Stock pattern 6-in. turned columns, 8 ft. long	3.00
Stock pattern, 8-in. colonial columns, 9 ft. long	7.50
Stock pattern 10-in. colonial columns, 9 ft. long	9.20
8-in. Doric column from detail, 9 ft. long	7.00
10-in. Doric column from detail, 9 ft. long	10.00
10-in. fluted column from detail, 9 ft. long	12.00
Short posts, 5 in. × 5 in. × 4 ft. 0 in	1.00
Short posts, 6 in. × 6 in. × 4 ft. 0 in	1.50

Balusters, 1¾ in., 14 to 16 in. long	$0.10 to $0.15
Railing, 1¾ in. × 3¾ in., per ft	.10
Railing, 2¼ in. × 3¾ in., per ft	.12
Tin roof, per square	$10.00 to 12.00

Unit Estimates of Amount and Cost of Labor

Amount of Work per Day. Two carpenters working in pairs should be able to put up in a day approximately one of the following amounts:

300 ft. B. M. of studding
300 ft. B. M. of rafters
600 ft. B. M. of floor joists
800 ft. B. M. of wall or roof boarding
600 ft. B. M. of matched boarding
500 ft. B. M. of diagonal matched boarding

One carpenter in one day should be able to accomplish any one of the following amounts of work:

Put up 400 ft. of plaster grounds
Put up 40 pairs of bridging
Set 1 window complete, frame, sash, and fittings
Set 1 door complete, frame, casing, hardware, and hanging
Case 4 windows
Hang and fit 10 pairs of blinds
Hang and fit 5 doors
Case 5 doors

Cost of Labor per Square. The cost of labor, reckoned on the basis of 100 square feet, may be estimated at the following rates:

Framing floors	$2.00
Framing walls	2.00
Framing plain roofs	2.00
Framing hip and valley roofs	2.25
Heavy framing	1.80
Boarding walls	1.00
Boarding walls with matched boards	1.25
Boarding walls diagonally	1.25
Boarding roofs	1.25
Laying rough floor	1.00

Laying rough floor diagonally	$1.25
Bridging floors	.50
Furring brick walls 12 in. on centers	2.00
Furring brick walls 16 in. on centers	1.25
Laying spruce upper floor, 6-in. stock	2.00
Laying spruce upper floor, 4-in. stock	2.25
Laying hardwood floors, 2½-in. stock	3.50
Shingling walls and roofs	3.00
Clapboarding walls	3.00
Papering walls under shingles or clapboards	.25

Cost of Labor by the Piece. Reckoned as piece work, the cost of labor on carpentry work will be approximately as follows:

Making window frames, each	$1.75
Making door frames, each	1.25
Making door frames with transom, each	2.00
Setting window frames, each	.50
Setting window frames in brickwork	.75
Hanging blinds, per pair	.50
Fitting and hanging sashes, per pair	.75
Hanging transoms, each	.50
Casing windows, each	1.00
Casing large size windows, each	2.00
Casing attic and cellar windows, each	1.00
Casing door opening, one side	.50
Casing door opening, both sides	.75
Fitting, hanging, and trimming inside door	.75
Fitting, hanging, and trimming outside door	1.25
Fitting, hanging, and trimming sliding doors, per pair	18.00
Finishing common closet	2.00

STAIRS

The trade of stair building, while a part of the general work of joinery, is usually taken up as a separate trade by men who do nothing else. For this reason it is better, if possible, to have the stairs figured and built by a regular stair builder, who will have the special tools, molds, and stock necessary for this branch of carpenter work.

There are usually in every house, two sets of stairs, one in the front part and one in the back part. Sometimes the stairs are so arranged as to come together in the second story, dividing somewhere in their height upon a common landing, one part, the larger and more elaborate, running to the front hall, and the other to the back hall or kitchen, Fig. 14. This is called a combination staircase and is often an economical solution of the problem of front and back stairs.

When two separate staircases are put in, each will have a distinct character, and it is this condition that we shall consider.

Front Stairs. The front stairs of ordinary width and elaboration, say from 3 feet to 4 feet wide, with turned balusters and molded rails and posts, in whitewood or North Carolina pine, may be approximately estimated from $4.50 to $6.00 per step, complete. This is on the basis of $2.50 per step for labor, the remainder for the stock. Paneling in connection with the stairs should be figured from $0.50 to $1.00 per square foot of which one-half will be labor and the other half the stock. For ash add 50 per cent to these estimates, for oak 75 per cent.

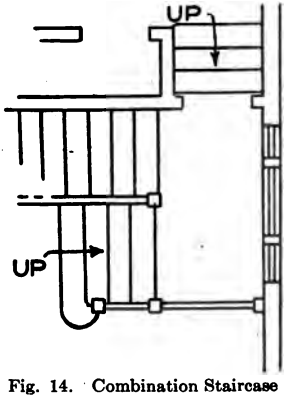


Fig. 14. Combination Staircase

The cost of winding steps will be about double that of straight steps for material, but the labor will be increased only about 50 per cent. This price will be sufficient for hard pine treads and plain molded rail with 1½ inch turned balusters, two to a tread.

No more definite data can be given for the front stairs, as there is such a wide variation in design and finish, and such a wide range in selection of posts, rails, and balusters.

In general a good molded and paneled newel may be had for from $5 to $8; landing posts from $3 to $4, rail from 18 to 20 cents per linear foot, balusters from 9 to 15 cents each. Balusters turned in colonial pattern with an upper shaft, a square, and an urn-shaped turning at the base, Fig. 15, cost, turned to detail, about 20 cents; if twisted, 30 cents more.

These prices are for open-string stairs; if brackets are used on the outside stringer, it will add from 12 to 15 cents per step.

Back Stairs. Common box stairs, for general use in the back and attic portions of a house, cost about $2.00 per step, this price including $1.25 for stock and 75 cents for labor. Winders will be used more frequently here than in front stairs and will cost about double the price of a straight step.

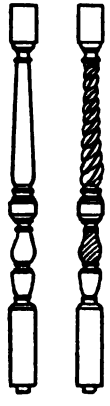


Fig. 15. Baluster in Colonial Pattern

Open cellar stairs of plank with no risers cost about $1.00 per step, giving 50 cents for labor and 50 cents for stock.

Summary. From the foregoing it will be found that a flight of front stairs in whitewood will cost, at the average run of 16 steps, about $80; in ash they will cost $120; in oak, $150. This is a fair price for good plain work that will give a satisfactory result.

The back stairs at 15 steps will cost $30, and the cellar stairs $12. Under conditions where much of the handrailing could be done away with, the prices could be reduced considerably.

HARDWARE

The best way to get at the cost of hardware is to secure a schedule and price for each job from the dealer. The price of hardware is constantly changing. Prices are given here for a few staple articles of ordinary value.

Nails per cwt	$2.50 to $4.00
Front door set, bronze metal	7.00 to 10.00
Vestibule door set	6.00 to 8.00
Inside door set	1.00 to 1.50
Store door set	6.00 to 12.00
Single sliding door set	1.50 to 3.00
Double sliding door	2.00 to 3.00
Double acting floor hinge, per pair	3.50 up
Double acting spring hinge, per pair	2.00 up
Window fixture, weights, etc	1.10 up
Sash fast, each	.25 to .35
Transom fixture	.30 to .50
Cupboard door set	.60

Folding door bolts	$1.25 to $3.00
Flush bolts, per pair	1.50
Butts, small size, per pair	.25
Butts, ordinary size, per pair	.30 to .40
Double coat and hat hooks, per dozen	2.50
Screws, bronze, per gross	.85
Single sliding door hanger	2.50 to 3.75
Double sliding door hanger	3.50 to 5.50

Nails. Nails are priced from a base price per hundredweight adopted by the manufacturers, which includes certain sizes of the more common kinds. From this base the different kinds of nails are priced by means of extras, as agreed upon. The present base includes common, fence, and sheathing nails, in sizes from 20 penny to 60 penny.

Following are schedules for all kinds of cut and wire nails in general use, and the extra price of each kind per hundredweight about the base, which is $2.85 per hundredweight, for cut nails and $2.85 per hundredweight for wire nails.

National List of Extras for Cut Nails in Fair Assortment per Hundred weight

Adopted Dec. 1, 1896.

BASE PRICE*—

Common Fence, and Sheathing Nails, 20-d to 60-d, per cwt. $2.85

Common, Fence, and Sheathing

SIZE†	EXTRA
10-d to 16-d	$0.05
8-d and 9-d	.10
6-d and 7-d	.20
4-d and 5-d	.30
3½-d	.40
3-d	.45
3-d fine	.65
2-d	.70

Spikes

All sizes	$0.10

Casing, Box, and Floor

SIZE	EXTRA
10-d and larger	$0.15
8-d and 9-d	.25
6-d and 7-d	.35
4-d and 5-d	.50
3-d	.70
2-d	1.00

Slating

6-d	$0.40
4-d and 5-d	.50
3-d	.75
2-d	1.00

*The base is variable.

†The length of the nail is regulated according to the penny, which formerly had reference to the weight, but is now purely arbitrary. Below are given the ordinary sizes and the corresponding lengths.

Fine Finishing

Size	Extra
10-d and larger	$0.25
8-d and 9-d	.35
6-d and 7-d	.45
4-d and 5-d	.65

Barrel, Roofing, and Cottage

1½ in.	$0.30
1⅜ in.	.40
1¼ in.	.50
1⅛ in.	.60
1 in.	.70
⅞ in.	.85
¾ in.	1.00

Clinch

Size	Extra
3 in. and larger	$0.45
2¾ and 2½ in.	.55
2¼ and 2 in.	.65
1¾ and 1½ in.	.75
1¼ in.	.95
1 in.	1.15

10c for each half-keg

4-d Swedes Genuine	$1.30
4-d Swedes Common	.80

Galvanizing ..... 2½c. per lb.
Tinning ..... 3c. per lb.

Size	2-d	3-d	3½-d	4-d	5-d	6-d	7-d	8-d	9-d	10-d
Length	1	1¼	1⅜	1½	1¾	2	2¼	2½	2¾	3

Size	12-d	20-d	30-d	40-d	50-d	60-d
Length	3½	4	4½	5	5½	6

National List of Extras for Wire Nails per Hundredweight

Adopted Dec. 1, 1896

Base Price*—

Common, Fence, and Flooring Nails, 20-d to 60-d, per cwt. $2.85

Common, Fence, and Flooring

Size	Extra
10-d to 16-d	$0.05
8-d and 9-d	.10
6-d and 7-d	.20
4-d and 5-d	.30
3½-d	.40
3-d	.45
3-d fine	.50
2-d	.70

Barbed Common and Barbed Car Nails

All sizes	$0.15

Slating

Size	Extra
2-d	$0.80
3-d	.60
4-d and 5-d	.40
6-d	.30

Casing and Smooth Box

10-d and larger	$0.15
8-d and 9-d	.25
6-d and 7-d	.35
4-d and 5-d	.50
3-d	.70
2-d	1.00

*The base is variable.

Barbed Box

Size	Extra
All sizes, advance over smooth	$0.15

Smooth Finishing Nails

10-d and larger	$0.25
8-d and 9-d	.35
6-d and 7-d	.45
4-d and 5-d	.65
3-d	.85
2-d	1.15

Barrel

¾ in.	$1.00
⅞ in.	.85
1 in.	.70
1⅛ in.	.60
1¼ in.	.50
1⅜ in.	.40
1½ in.	.30

Clinch

2-d	$1.05
3-d	.85
4-d and 5-d	.65
6-d and 7-d	.55
8-d and 9-d	.45
10-d	
12-d and 16-d	.35
20-d	

Wire Spikes

All sizes	$0.10

Miscellaneous Data

Broken stone filling per cu. yd	$ 2.50
Cesspool, 6 ft. diam. and 8 ft. deep, 8 in. brick	60.00
Blind drains per linear ft	.12
Earthen drains 4 in. diam., laid, per foot	.20
Arch brick laid in wall, per M	100.00
Marble mosaic, per sq. ft	1.00
Marble threshold, exterior	5.00
Marble base, per foot	.50
Granolithic, per sq. ft	.15
Steel beams, per lb	.04
Cast iron, per lb	.03
Copper skylights, heavy, per sq. ft	$1.75 to 2.50
Plastering, 2 coats on wire lath	.65
Wooden balustrade, per ft	2.00
Store sash, 1¾ in. per linear ft	.30
Storm sash for house, average	1.55
Outside door frame with transom	3.50
Factory window complete, 4 ft. 0 in. × 8 ft. 0 in.	15.00
Lumber planed, per M	2.00
Plank floor laid, per M	9.00
Shingle roof, per square	8.00
Zinc flashings, for each inch of width, per ft	.02

ROOFING

Many kinds of material are used for covering roofs, depending upon the nature of the work, the pitch of the roof, the desired appearance, and the availability of material.

Shingles. The roof covering of an ordinary wooden house is, generally, of shingles. These may be either shaved or sawed, but sawed shingles are usually used. Sawed shingles come in bundles of 250, or 4 bundles to the thousand. These quantities are based on a width of 4 inches to each shingle so that if they are wider they will be fewer in number, and if narrower, there will be more in number. Common shingles are from 16 inches to 18 inches in length.

Quantities. In measuring for shingles, the quantities are usually taken off in the unit of 100 square feet, and the number of shingles required depends upon the lap or exposure which is given to them. On roofs, the exposed length is usually 4½ inches, and on walls, 5 or 6 inches, although in the carrying out of special designs a greater or less exposure may be given.

The covering capacity of 1,000 shingles at various exposures may be tabulated as follows:

Exposure of Shingles to Weather	Area Covered by 1,000 Shingles	No. Shingles Required per Square
4 in.	111 sq. ft.	900
4½ in.	125 sq. ft.	800
5 in.	139 sq. ft.	720
6 in.	167 sq. ft.	600
7 in.	194 sq. ft.	514
8 in.	222 sq. ft.	450

Cost. Sawed cedar shingles of best quality marked "Extra" will cost from $4.50 to $5.00 per thousand, and "clear" shingles, that is, shingles having the exposed lower third of clear stock, cost from $4.00 to $4.50 per thousand, and require 5 pounds of 4-penny nails. These cost 3 cents a pound if plain, or 5 cents if galvanized.

A carpenter in one day of 8 hours will lay 1,500 shingles on plain work, or 1,000 if surface is much cut up. This will cost, at $4.56 per day from $3.00 to $4.50.

In estimating shingling an allowance will be necessary for waste; this should be about 5 per cent on plain roofs, and 8 to 10 per cent on roofs with many hips, valleys, or dormers.

Slating. *Quantities.* Slates are made in different sizes from 6 by 12 inches up to 16 by 24 inches, and larger sizes for special work. They are laid with reference to head-cover rather than exposure: i.e., the lap of cover of each course by the second above it, gives the gage to which slates should be laid, Fig. 16; this lap is usually 3 inches, so that the exposed length of any slate may be found by subtracting that amount from the length of the slate and dividing by 2. This exposure multiplied by the width of the slate gives the exposed area of the slate; the number of slates in a given area may be found by dividing the area in square inches by the exposed area of the slate.

Example. How many slates will be required per square to cover a roof if 8- by 4-inch slates are used?

Solution.

$$\frac{14 \text{ in.} - 3 \text{ in.}}{2} = 5\tfrac{1}{2} \text{ in.}$$

$$8 \text{ in.} \times 5\tfrac{1}{2} \text{ in.} = 44 \text{ sq. in.}$$

$$14{,}400 \text{ sq. in.} \div 44 \text{ sq. in.} = 327, \text{ No. of slates required}$$

In measuring a slate roof it is usual to allow an extra width of from 6 inches to 12 inches, according to localities, on hips, valleys, eaves, and wall cuttings, to allow for the extra work involved. Extra charge should be made for towers and all varied forms of roof.

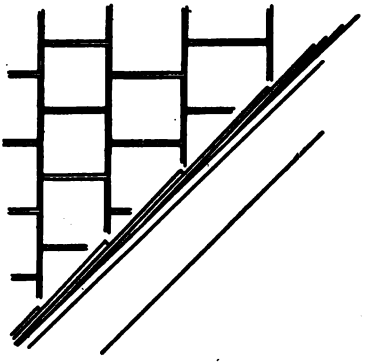


Fig. 16. Slating

The number of slates required to cover a square of roofing is given below for various sizes of slates:

Size of Slates	No. of Slates	Size of Slates	No. of Slates
6 × 12 in.	533	10 × 20 in.	165
7 × 14 in.	377	11 × 22 in.	138
8 × 16 in.	277	12 × 24 in.	114
9 × 18 in.	214	14 × 28 in.	83

Cost. The cost of slating per square is as follows:

Slates, 10 in. × 16 in.	$7.50
Labor 1 day	4.80
Nails	.20
Roofing paper	.50
Labor on paper	.25
Total	$13.25

Tiles. Where a special feature is to be made of the roof, tiles are often used; but these are found in such a variety of shapes, sizes, and prices, that a roof of this sort should always be given to a roofer to estimate.

Metal Roofs. Copper or tin is generally used for roofs where a metal covering is desired. Copper roofs, if steep enough to show as a feature of the building, are usually laid with ribs over battens. This makes a handsome and durable roof, and does not greatly increase the cost. Copper roofing, plain, costs per square $40 to $42; copper roofing with battens costs per square $60. Copper flashings around skylights and balustrades cost from 40 cents to 60 cents per linear foot.

For a cheaper metal roof, tin is generally used; this may be used on steep or flat roofs. Tin for roofing should be painted on the under side and carefully soldered on the top. Tin roofing costs from $11 to $12 a square.

Composition Roofs. For flat roofs, a composition of tar and paper in layers finished with a protective coat of gravel, is often used; the cost of this depends upon the number of layers of paper and "moppings" of tar required. A 5-ply roof gives good service and costs about $6.00 a square.

Gutters and Conductors. Gutters and conductors are both made of wood or metal, metal being preferred in all cases. For metal gutters, copper and glavanized iron are used. Prices for gutters and conductors are as follows:

Copper gutters, per ft	$ 1.50
Copper conductors, per ft	$0.50 to .75
Goosenecks, each	5.00 to 10.00
Molded conductor heads	4.00 to 10.00
Straps, each	1.00
Galvanized iron gutters, per ft	.90
Galvanized iron conductors, per ft	$0.18 to .20

QUANTITIES LATHING AND PLASTERING

Plastering is measured by the square yard, and is usually done in 2-coat or 3-coat work. In taking off plastering, it is customary to deduct only one-half of the area of openings to allow for the extra work of plastering to the grounds. In some localities no

opening is deducted unless it is more than 7 square yards in area, but in close figuring this is not generally followed.

Narrow strips, such as chimney breasts, if less than a foot wide, are generally called a foot. Round corners, beads, and arrises must be taken separately by the lineal foot.

Raking surfaces require additional work and should be taken at about one-half more than plain work. Circular or elliptical work should be charged at two prices, and domes, groins, and intersecting soffits, at three prices. Cornices are taken by the square foot of girth, with enrichments charged separately by the lineal foot.

Standard Practice. In some portions of the country rules have been adopted governing the valuing of plasterer's work which are in the main as follows:

First. Measure on all walls and ceilings the surface actually plastered, without deducting any grounds or any openings of less extent than 7 superficial yards.

Second. Returns of chimney-breasts, pilasters, and all strips of plastering less than 12 inches in width, measure as 12 inches wide; where the plastering is finished down to the base, surbase, or wainscoting, add 6 inches to height of walls.

Third. In closets, add one-half to the measurement. For raking ceilings and soffits of stairs, add one-half to the measurement; for circular or elliptical work, charge two prices; for domes or groined ceilings, three prices.

Fourth. For each 12 feet of interior work done more than 12 feet above the ground, add 5 per cent; for outside work, add 1 per cent for each foot that the work is done above the first twelve feet.

Stucco-work is generally governed by the following rules:

Moldings less than 1 foot girt are rated as 1 foot, over 1 foot, to be taken superficial. When work requires two molds to run the same cornice, add one-fifth. For each internal angle or miter, add 1 foot to length of cornice; and for each external angle, add 2 feet. All small sections of cornice less than 12 inches long measure as 12 inches. For raking cornices, add one-half for circular or elliptical work, double the price; for domes and groins, charge three prices. For enrichments of all kinds a special price must be charged. The higher the work is above ground, the higher the charge must be; add to it at the rate of 5 per cent for every 12 feet above the first 12 feet.

Cost. Lathing is generally included in the plasterer's price although put up by a different set of men. Lathing is estimated by the square yard or by the thousand laths, the price for the latter being from $3.00 to $4.00.

Two plasterers requiring one helper will do from 40 to 50 square yards of 3-coat plastering, or 60 to 70 square yards of 2-coat work, in a day of 8 hours; from 1,200 to 1,500 laths make a day's work for one lather.

Two-Coat Work. One hundred square yards of lath and plaster for 2-coat work cost about as follows:

LATHING—	
1,500 laths at $4.75 per M	$7.12
10 lb. 3-d nails, at $3.20 per cwt	.32
Labor	5.62
PLASTERING—	
10 bu. lime at $0.48	4.80
6 lb. hair at $0.06½	.39
1 load sand	1.80
Plasterer 3 days at $5.60	16.80
Helper 1½ days at $3.60	5.40
Cartage	1.00
Total	$43.25
Cost per sq. yd	.44

This scale makes 44 cents the net price for one square yard with no profit added. The cost of plastering is on the increase, and while the work is done in the country towns as low as 40 cents per yard, it will not be safe to use this price for any length of time.

Three-Coat Work. For 3-coat work we may take the following schedule:

LATHS, and putting on, as above	$13.06
PLASTERING—	
13 bu. lime at $0.48	6.24
8 lb. hair at $0.06½	.52
1½ loads sand at $1.80	2.70
1 bbl. plaster of Paris	2.00
Plasterer 4 days at $5.60	22.40
Helper 2 days at $3.60	7.20
Cartage	1.50
Total	$55.62
Cost per sq. yd	.55

PAINTING

Quantities. Painting is estimated by the yard, doors and windows being taken solid to make up for the extra labor of cutting in the sashes and moldings.

Railings, fences, grilles, and similar surfaces are taken solid.

A painter in one day will cover 100 square yards of outside work with one priming coat, or 80 square yards with the second coat. Ten pairs of blinds will make a day's work.

On the first coat, 1 pound of paint will cover about 4 square yards; and on subsequent coats, 1 pound will cover 6 square yards. One pound of putty for stopping will cover 20 square yards.

Shingle stains require a gallon for every 500 shingles if dipped two-thirds in; for a brush coat after laying, a gallon will cover about 200 square feet of surface, or 1,500 shingles.

Below are given the number of square yards covered by one gallon of paint of various kinds.

PRIMING COAT—

1 gal. priming color covers.....50 sq. yd.
1 gal. zinc white covers.....50 sq. yd.

FINISHING COAT—

1 gal. white paint covers.....44 sq. yd.
1 gal. black paint covers.....50 sq. yd.
1 gal. stone color covers.....44 sq. yd.
1 gal. yellow paint covers.....44 sq. yd.
1 gal. green paint covers.....45 sq. yd.
1 gal. emerald green covers.....25 sq. yd.
1 gal. bronze green covers.....75 sq. yd.

The following tabulation gives the comparative spreading power of paints on wood, metal, and plaster. The figures represent the number of square feet of surface covered by ten pounds of paint of the usual consistency, applied evenly with a brush.

ON WOOD—	FIRST COAT	SECOND COAT
10 lb. red lead cover	112 sq. ft.	252 sq. ft.
10 lb. white zinc cover	221 sq. ft.	324 sq. ft.
10 lb. oxide of zinc cover	378 sq. ft.	453 sq. ft.
10 lb. red oxide cover	453 sq. ft.	540 sq. ft.
10 lb. raw linseed oil cover	756 sq. ft.	872 sq. ft.
10 lb. boiled linseed oil cover	412 sq. ft.	540 sq. ft.

ON METAL—

10 lb. red lead cover.....477 sq. ft.
10 lb. white lead cover.....648 sq. ft.

10 lb. oxide of zinc cover.....1134 sq. ft.
10 lb. red oxide cover.....870 sq. ft.
10 lb. raw linseed oil cover.....1417 sq. ft.
10 lb. boiled linseed oil cover.....1296 sq. ft.

ON PLASTER—

10 lb. red lead cover.....324 sq. ft.
10 lb. white lead (on sized wall) cover..362 sq. ft.
10 lb. oxide of zinc cover.....594 sq. ft.
10 lb. raw linseed oil (unsized wall) cover 55 sq. ft. 99 sq. ft.

Estimating Cost. *Inside Work.* The cost of painting varies under different conditions, but average prices may be taken as follows:

PAINTING—

1 coat per sq. yd	$0.12
2 coats, per sq. yd	.20
3 coats, per sq. yd	.25
1 coat shellac, per sq. yd	.10
1 coat size and 2 coats paint	.25
1 coat size and 3 coats paint stipple	.35

VARNISHING—

1 coat liquid filler, 1 coat varnish	$0.25
1 coat liquid filler, 2 coats varnish	.30
1 coat liquid filler, 3 coats varnish	.35
1 coat paste filler, 1 coat varnish	.30
1 coat paste filler, 2 coats varnish	.35
1 coat paste filler, 3 coats varnish	.40

Tinting walls in distemper costs 15 cents per square yard for small amounts, and 10 cents per square yard for 50 yards or more. Finishing hard wood floors with filler, shellac, and 2 coats of varnish or wax finish costs 35 cents per square yard.

Outside Work. The following estimates are given for outside painting and sanding:

PAINTING—

1 coat new work, per sq. yd	$0.12
2 coats new work, per sq. yd	.20
3 coats new work, per sq. yd	.25

SANDING—

2 coats paint, 1 coat sand, per sq. yd	$0.28
3 coats paint, 1 coat sand, per sq. yd	.35
3 coats paint, 2 coats sand, per sq. yd	.50

Painting on brick costs 15 cents per yard for the first coat, but subsequent coats cost no more than on wood.

Tin roofs can be painted one coat for 5 cents a yard.

Shingles dipped two-thirds of their length cost at the rate of 1,000 for $3.00; a brush coat in addition costs 50 cents.

Blinds are rated at $1.50 per pair for an average size.

HEATING

The heating of a building is generally made the subject of a special contract. The three usual methods for house heating are, the hot-air furnace, the hot-water boiler, and the steam boiler. Sometimes a combination system of hot air and steam, or hot air and hot water is used.

Estimates of the cost of heating should be obtained from contractors who follow this particular branch of construction. In general, for an ordinary class of building such as residences, apartments, stores, etc., the cost of heating will range, according to the system used, from 6 per cent to 12 per cent of the cost of the building: the cost of the hot-air furnace will be from 6 to 7 per cent; of steam from 8 to 10 per cent; and of hot water from 10 to 12 per cent. These figures are approximate and the only reliable way to obtain the actual cost is by taking off the items and figuring each job by itself.

Hot-Air Heating

Quantities. The hot-air heating of an ordinary house is determined on the basis of the cubic contents to be heated; the area of piping and capacity of furnace can be closely approximated by means of the following general rule:

To determine the size of pipe for any room, find the contents of the room in cubic feet, and divide this by 25 for rooms on the first floor, and by 35 for rooms on the second and third floors.

Example. Determine the piping for a house, the dimensions of whose rooms are as given on page 50.

Solution. The piping for both first and second floor rooms will be as follows:

FIRST FLOOR ROOMS—

Living-room (dimensions 12×15×9)

(12×15×9) ÷25 = 1,624 ÷25 = 65 sq. in. area of pipe
= 9 in., diameter of pipe

Hall (8×20×9; 40 per cent to be added for second story hall)

(8×20×9) ÷25 = 1,440 ÷25 = 58 sq. in.
58 sq. in. +23 sq. in. (40 per cent) = 81 sq. in., area of pipe
= 10 in., diameter of pipe

Dining-room (14×15×9)

(14×15×9) ÷25 = 1,890 ÷25 = 76 sq. in., area of pipe
= 10 in., diameter of pipe

SECOND FLOOR ROOMS—

Chamber (13×15×8½)

(13×15×8½) ÷35 = 1,658 ÷35 = 48 sq. in., area of pipe
= 8 in., diameter of pipe

Chamber (11×12×8½)

(11×12×8½) ÷35 = 1,122 ÷35 = 32 sq. in., area of pipe
= 7 in., diameter of pipe

Chamber (14×16×8½)

(14×16×8½) ÷35 = 1,904 ÷35 = 55 sq. in., area of pipe
= 8 in., diameter of pipe

Bathroom (8×10×8½)

(8×10×8½) ÷35 = 680 ÷35 = 20 sq. in., area of pipe
= 7 in., diameter of pipe

The whole piping area will be as follows:

Two	10-in. pipes = 2×78 =	156 sq. in.
One	9-in. pipe =	64 sq. in.
Two	8-in. pipes = 2×50 =	100 sq. in.
Two	7-in. pipes = 2×38 =	76 sq. in.
Total		396 sq. in.

Cost. A furnace to carry say 400 to 500 square feet of pipe area will cost, set in place, from $125 to $150. The labor on pipes, registers, and furnace will be from $25 to $30.

The cost of piping depends on the distances to run, but the material can be estimated according to the schedule given below. Round *tin pipes* will cost, from A. A. charcoal plates, as follows:

ITEMS IN COST	SIZE OF PIPE											
	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.	12 in.	13 in.	14 in.	15 in.	16 in.	18 in.
Pipe, per ft.	$0.13	$0.14	$0.15	$0.17	$0.18	$0.23	$0.25	$0.27	$0.29	$0.31	$0.34	$0.41
Hot-air damper	.19	.19	.21	.22	.24	.25	.26	.26	.27	.28	.28	.32
Furnace collars	.18	.18	.21	.24	.27	.30	.36	.36	.38	.40	.40	.50
Tin elbows	.18	.20	.22	.26	.29	.35	.40	.50	.59	.66	.74	.81

The cost of *registers* may be estimated as follows:

Items in Cost	Size of Registers									
	6x10 in.	7x10 in.	8x10 in.	8x12 in.	9x12 in.	10x14 in.	12x15 in.	12x16 in.	14x18 in.	16x20 in.
Black register	$0.78	$0.83	$0.83	$0.96	$1.06	$1.71	$2.22	$2.73	$4.05	$5.53
Slate stone	.45	.50	.52	.59	.74	.83	1.10	1.19	1.80	2.91
Register box	.20	.24	.24	.26	.30	.31	.35	.42	.57	.72
Netting	.05	.05	.06	.06	.07	.07	.08	.08	.10	.12
Total	$1.48	$1.62	$1.65	$1.87	$2.17	$2.92	$3.75	$4.42	$6.52	$9.28

Galvanized *smoke pipe* will cost 12 cents per pound and weighs per linear foot as follows:

Size No.	Size of Pipe										
	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.	12 in.	13 in.	14 in.
22	1¾ lb.	2¼ lb.	2¾ lb.	3 lb.	3¾ lb.	3½ lb.	4½ lb.	4½ lb.	5 lb.	5½ lb.	5¾ lb.
24	1¼ lb.	1⅝ lb.	1¾ lb.	2¼ lb.	2½ lb.	2¾ lb.	3 lb.	3⅜ lb.	3¾ lb.	3¾ lb.	4¼ lb.

Galvanized elbows weigh and cost as follows:

Size of Elbow (in.)	Weight (lb.)	Cost
4	1	$0.26
4½	1¼	.27
5	1½	.29
5½	1¾	.30
6	2¼	.31
7	2¾	.32
8	3¼	.36

The cost of *tin* for sheets of various sizes and weights is as follows:

Weight	Size (in.)	Price (per ft.)
DC	12½×17	$0.05
IX	14 ×20	.07
IXX	14 ×20	.08
IX	20 ×23	.12
IX	20 ×26	.13
IX	20 ×29½	.16
IX	20 ×32½	.17

Miscellaneous Cost Data for Installation of Hot-Air Heating

Galvanized sheet iron per lb	$0.06
Common sheet iron per lb	.04
Wrought iron per lb	.04

Galvanized piping per lb	$0.12
Galvanized cold-air box per lb	.12
Galvanized furnace shields per sq. ft	.10
Register box netting per sq. ft	.05
Asbestos paper at 1½ lb. per sq. yd	.05

Miscellaneous Rules for Installation of Hot-Air Heating

Figure the cold-air supply as three-quarters combined area of piping.

Register grilles take up one-third of area of register.

Locate registers nearest convenient point to furnace, inside part of room preferred.

Locate the furnace so that all pipes will be as nearly equal in length as possible.

Estimate pipes by linear foot, but elbows and dampers separately, also registers with boxes and borders.

Allow from $1.25 to $1.75 for flange connection of cold-air box to furnace casing.

Cover all risers with asbestos paper in partitions.

Hot-Water and Steam Heating

In estimating for heating with hot water, all pipes and fittings must be taken off and listed, all standard radiators priced by the square foot of radiation, and special radiators, tanks, valves, hangers, etc., listed separately.

Radiators are listed in the trade catalogues, together with the number of square feet in each section. These prices are subject to varying discounts which can be obtained of the manufacturers.

The amount of radiation necessary for each room depends upon so many varying conditions that all rules are in a way approximate. Certain formulas may be used, which will give good results in ordinary cases, but just what allowances are necessary must be determined by the heating engineer. The same is true of making the estimates of hot water or steam and the contractor should in all cases have the job figured by an expert.

In ordinary cases the amount of radiation necessary for *steam* heating may be estimated from the cubic contents of the rooms to be heated according to the following rule:

One Square Foot of Radiation Heats	Dwellings (cu. ft.)	Halls, Stores, Etc. (cu. ft.)	Churches and Auditoriums (cu. ft.)
By direct radiation			
On first floor	35 to 60	75 to 100	125 to 200
On upper floors	50 to 80	.....	.....
By indirect radiation			
On first floor	25 to 40	50 to 70	80 to 135
On upper floors	40 to 50	.....	.....

The amount of radiation necessary for *hot-water* heating is estimated by similar rules.

One Square Foot of Radiation Heats	Dwellings (cu. ft.)	Halls, Stores, Etc. (cu. ft.)	Churches and Auditoriums (cu. ft.)
By direct radiation			
On first floor	15 to 25	30 to 45	50 to 85
On upper floors	25 to 40	.....	.....
By indirect radiation			
On first floor	17 to 40	45 to 65	80 to 125
On upper floors	25 to 35	.....	.....

Having determined the amount of radiation, piping, and fittings, the amount of labor may be obtained by adding about 20 per cent to the cost of materials.

PLUMBING

So wide a range is possible in the selection and price of plumbing fixtures that no very useful data can be given for a complete installation. For instance, in one house, a single bathroom, fitted up to meet the fancies and purse of the one man, may cost more than the whole plumbing outfit of his more modest neighbor. Nevertheless, it is a fact that the plumbing of a house is a poor place to practice economy, as no part of the construction of a building needs more careful attention in execution or in selection.

In general, a good job of plumbing costs about 10 per cent of the cost of the building and of this outlay about 30 per cent represents the labor. In taking off plumbing, the contractor should begin at the sewer or cesspool, if the drains are included, or, if not, at the outer end of the soil pipe, and take off carefully every pipe with its fittings, which should be itemized carefully as this data will be useful in getting at the amount of calking, fitting, etc.

Cost of Pipes and Fittings. Soil pipes should be estimated by the linear foot, ¾ pound of lead for every inch in diameter of the pipe being allowed in each joint.

From the dealers can be obtained list prices of pipe and fittings, which are subject to discount; these vary from time to time, but the present discounts will be found to bring the prices of the more common *drainage* materials about as follows:

4-in. extra heavy soil pipe, per ft	$0.36
3-in. extra heavy soil pipe, per ft	.27
2-in. extra heavy soil pipe, per ft	.18
For fittings add 35 per cent	
4-in. running trap	2.75
4-in. brass ferrule cleanout	1.07
4-in. lead bend	1.83
4-in. brass ferrule	1.00
2-in. brass ferrule	.54
Solder per lb	.40

Below are listed the prices of various materials used in the installation of water.

40 gal. galvanized boiler and stand	$18.00
1-in. brass pipe, per ft	.88
1-in. galvanized pipe, per ft	.15
¾-in. galvanized pipe, per ft	.10
½-in. galvanized pipe, per ft	.08
1-in. stop and waste cock	1.78
¾-in. stop and waste cock	1.20
½-in. stop and waste cock	1.07
Sill cock	1.67
For fittings, add 30 per cent	

The more important water measurements with which the estimator should be familiar are given here. In Table IV are given the capacities of cisterns of different diameters.

1 cu. ft. measures 7.48 gal. = 29.92 qt.
1 cut. ft. weight 62.321 lb. = 1.004 oz.
1 cu. yd. weighs 1,692 lb.
1 gal. measures 231 cu. in.
1 gal. weighs 8⅓ lb.

TABLE IV

Capacity of Cisterns

IN GALLONS, FOR EACH FOOT IN DEPTH

DIAMETER* (ft.)	CAPACITY (gal.)	DIAMETER (ft.)	CAPACITY (gal.)
2.0	23.5	9.0	475.87
2.5	36.7	9.5	553.67
3.0	52.9	10.0	587.5
3.5	71.96	11.0	710.9
4.0	94.02	12.0	846.4
4.5	119.	13.0	992.9
5.0	146.8	14.0	1,151.5
5.5	177.7	15.0	1,321.9
6.0	211.6	20.0	2,350.0
6.5	248.22	25.0	3,570.7
7.0	287.84	30.0	5,287.7
7.5	330.48	35.0	7,189.
8.0	376.	40.0	9,367.2
8.5	424.44	45.0	11,893.2

1 ft. cylinder weight 49.1 lb.

1 in. cylinder weighs .028 lb.

1 bbl. contains 31½ gal.

No. of bbl. = contents in cu. ft. × .2375

No. of gal. in ft. of pipe = (diameter in in.)² × .04

Pressure per sq. in. = depth in ft. × .433

Pressure of 1 lb. per sq. in. given by column, 27.72 in. in depth

Pressure of 15 lb. per sq. in. (atmospheric pressure) given by column, 34 in. in depth

Head of water = pressure in lb. per sq. in. × 2.31

Supply for one person per day 15 gal.

Actual use per person each day from 6 to 12 gal.

Cost of Plumbing Fixtures. The prices of fixtures, as has been sa'd, vary greatly; the following figures represent the usual range:

3-ft. soapstone sink, complete.....$30.00 to $40.00

14 × 17-in. lavatory with marble slab and backpiece fitted, complete.....$35.00 to $50.00

Enameled iron lavatory, complete.....$25.00 to $40.00

5-ft. 6-in. enameled iron bath, complete..$60.00 to $100.00

Bathtub only.....$25.00 to $35.00

*For tanks that taper take diameter four-tenths from large end.

Soapstone laundry trays, complete

One part	$15.00 to $18.00
Two parts	$30.00 to $35.00
Three parts	$45.00 to $60.00

List prices of fittings may be obtained from all dealers, subject to large discounts, which should be considered frequently as they are constantly changing.

Cost of Labor. Having made a complete list of pipe, fittings, and fixtures, the labor of construction of an ordinary job of plumbing may be estimated from 25 to 50 per cent of the cost of materials.

GAS FITTING

As in plumbing, so in gasfitting, the wide range of selection and cost in fixtures makes it impossible to give satisfactory data with regard to cost.

The piping only, for an ordinary house, will cost from $1.75 to $2.50 an outlet, and the cost of the whole outfit should be from 3 to 5 per cent that of the house. Pipes of usual size cost per foot, as follows:

⅜-in. gas pipe	$0.03
½-in. gas pipe	.04
¾-in. gas pipe	.05
1½-in. main	.08

For fittings, add 25 per cent

ELECTRIC WORK

The original contract for a house usually provides for the wiring for electric lighting and bells, but the fixtures are generally left to a later agreement, as there is such a great latitude in selection and cost.

Wiring. For electric light wiring one of two systems is usually employed—the conduit system, where the wires are all run in pipes or conduits; and the knob-and-tube system, where the wires are run in the clear space between timbers, secured to porcelain knobs, or passing through short tubes of the same material.

In general, the rough wiring of a house may be reckoned from $5.00 to $5.50 per outlet for conduit work, and from $2.50 to $3.00

per outlet for knob-and-tube work. This is for every time the wires are brought to the surface, whether for switches, cut-outs, or fixtures. Another way is to allow $1.50 for each lamp or switch.

Wires are sold in coils which are marked with the gage and name of manufacturer, and should bear the label of inspection acceptable to the local insurance board.

The cost of wire varies with the gage and the insulation, but for usual house work it should be, for No. 14 wire, 1 cent a foot.

It is well to remember that, in electric wiring, the larger the house, the more per outlet the wiring will cost. This is contrary to expectation, but is occasioned by the smaller percentage of lights to length of wire.

Switches. Various kinds of switches are used, the two principal types being the push button and the rotary switch. These vary in price according to make and finish. A good rotary switch can be had at from 90 cents to $1.00; push button switches from 35 cents to $1.00; snap switches from 20 to 60 cents.

Bells. The number of call bells in a dwelling varies according to the plan and choice of the owner.

For an ordinary house the number would range from six to ten, and the cost should be from $18.00 to $25.00, or about $30.00 per bell.

FRONT VIEW OF RESIDENCE OF C. C. GATES, PASADENA, CALIFORNIA
George A. Clark, Designer, Pasadena, California

ESTIMATING

PART II

TYPICAL ESTIMATE FOR SUBURBAN DWELLING

The taking-off of quantities and making-up of an actual estimate, is the end toward which our efforts are now directed. This is done, as has been said, in a number of ways, no two persons arriving at the same conclusion or following exactly the same methods. To give the student a practical idea of how estimates are made, we shall now demonstrate the method of procedure in an actual instance. For this purpose, we shall take the case of the wooden colonial residence, the plans and working drawings for which, together with the method of making them, are fully described in "Architectural Drawing", and the details of which are described to a certain extent in "Building Superintendence".

The usual method followed is to take off the quantities in the order in which they occur in the specification or in the operation of building, beginning with "Excavation" and ending with "Painting".

Two methods of procedure are open to the contractor, which he may avail himself of according to his experience or confidence. He may take off simply his own particular branch of the work, relying on each subcontractor to give him a price for the detailed portions of the work; or, if he is a general contractor, he may, with the requisite knowledge of general building operations, take off all the quantities, pricing them according to his knowledge, and may submit his proposition on the basis of his own figures. The latter method requires great experience, and is followed generally only by large contractors, who have in their employ men whose business is mainly to take off quantities and make up estimates.

The following estimate has been carefully made up on the basis of the data given in Part I as to prices of materials and labor. In actual practice, details of more or less importance will vary in dif-

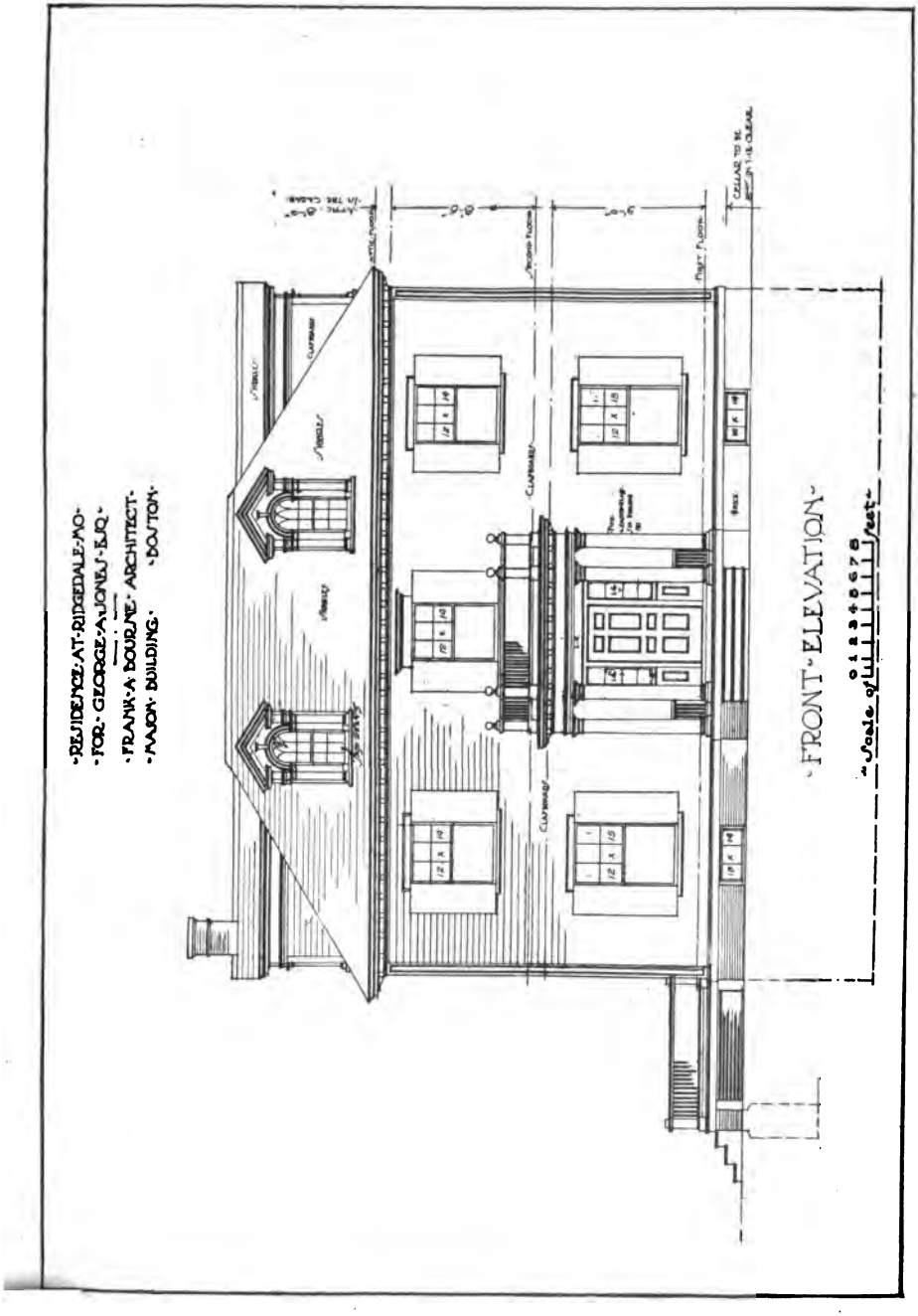


Fig. 17. Front Elevation of Colonial Residence

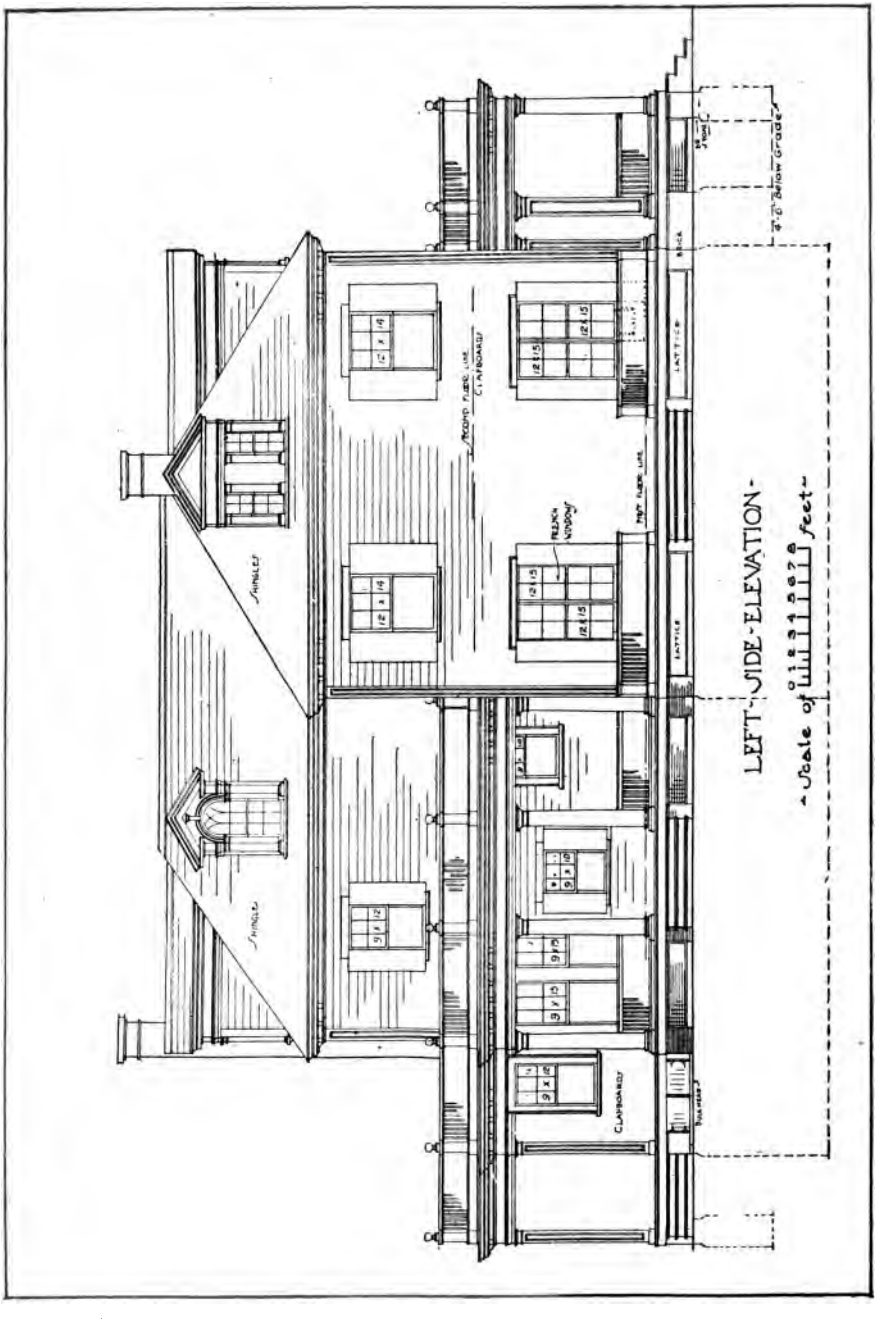


Fig. 18. Left Side Elevation of Colonial Residence

ferent localities and among different contractors; but the example here given illustrates the process fully.

ESTIMATE

FOR A RESIDENCE TO BE ERECTED FOR

GEORGE A. JONES, ESQ.

AT RIDGEDALE, MISSOURI

PRELIMINARY WORK

Staking out and setting batter boards	$25.00
Water supply during construction	15.00
	$40.00

EXCAVATION

NOTE.—Excavation is priced by the cubic yard; and in this regard, the distance to which the excavated material must be carted will be an important consideration. In the present case, the material is to be carried only a short distance, so that no unusual conditions will have to be considered.

As before mentioned, it is usually advisable to dig a cellar at least a foot larger all around than the sill line, so that plenty of room may be afforded to the mason to plaster the outside of the wall. This should be done without regard to the specifications. As this extra excavation lies entirely outside the line of the house, it may be well to take it off separately, remembering that it will extend down into the trench below the wall, making about 8 feet of height.

QUANTITIES—	CU. FT.
42 ft. 0 in. × 8 ft. 0 in. × 1 ft. 0 in	336
34 ft. 0 in. × 8 ft. 0 in. × 1 ft. 0 in	272
10 ft. 4 in. × 8 ft. 0 in. × 1 ft. 0 in	83
17 ft. 6 in. × 8 ft. 0 in. × 1 ft. 0 in	140
68 ft. 0 in. × 8 ft. 0 in. × 1 ft. 0 in	544
41 ft. 0 in. × 8 ft. 0 in. × 1 ft. 0 in	328
CELLAR EXCAVATIONS—	
28 ft. 0 in. × 43 ft. 0 in. × 5 ft. 6 in	6,622
12 ft. 6 in. × 3 ft. 0 in. × 5 ft. 6 in	206
26 ft. 0 in. × 20 ft. 6 in. × 5 ft. 6 in	2,931
9 ft. 0 in. × 6 ft. 6 in. × 5 ft. 6 in	322
Carried forward	11,784

Fig. 19. Detail of Front Elevation of the George A. Jones Residence

	Cu. Ft.
Brought forward	11,784
MISCELLANEOUS QUANTITIES—	
Piers	
2 ft. 0 in. × 2 ft. 0 in. × 3 ft. 6 in. × 12	168
Trench	
185 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	308
Area	
14 ft. 0 in. × 2 ft. 8 in. × 3 ft. 6 in	129
Drains	
123 ft. 0 in. × 3 ft. 6 in. × 1 ft. 6 in	645
Cesspools	
5 ft. 6 in. × 5 ft. 6 in. × 8 ft. 0 in	242
10 ft. 0 in. × 10 ft. 0 in. × 8 ft. 0 in	800
Dry Wells	
6 × 2 ft. 0 in. × 2 ft. 0 in. × 5 ft. 0 in	120
Total	14,196

Cost of Excavation—

14,196 cu. ft., or 525 cu. yds., at $.60 ..... $315.00

STONEWORK

DRY WALLS IN TRENCH—	Cu. Ft.
16 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	27
16 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	27
12 ft. 6 in. × 1 ft. 8 in. × 1 ft. 0 in	20.8
3 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	5
23 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	38
16 ft. 6 in. × 1 ft. 8 in. × 1 ft. 0 in	27.5
28 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	46
28 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	46
14 ft. 6 in. × 1 ft. 8 in. × 1 ft. 0 in	24
4 ft. 6 in. × 1 ft. 8 in. × 1 ft. 0 in	7.5
23 ft. 0 in. × 1 ft. 8 in. × 1 ft. 0 in	38
Total	306.8

307 cu. ft. ÷ 25 = 12 perches of dry wall

MORTAR WALLS—	Cu. Ft.
16 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in	175
16 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in	175
9 ft. 6 in. × 8 ft. 3 in. × 1 ft. 8 in	130
Carried forward	408

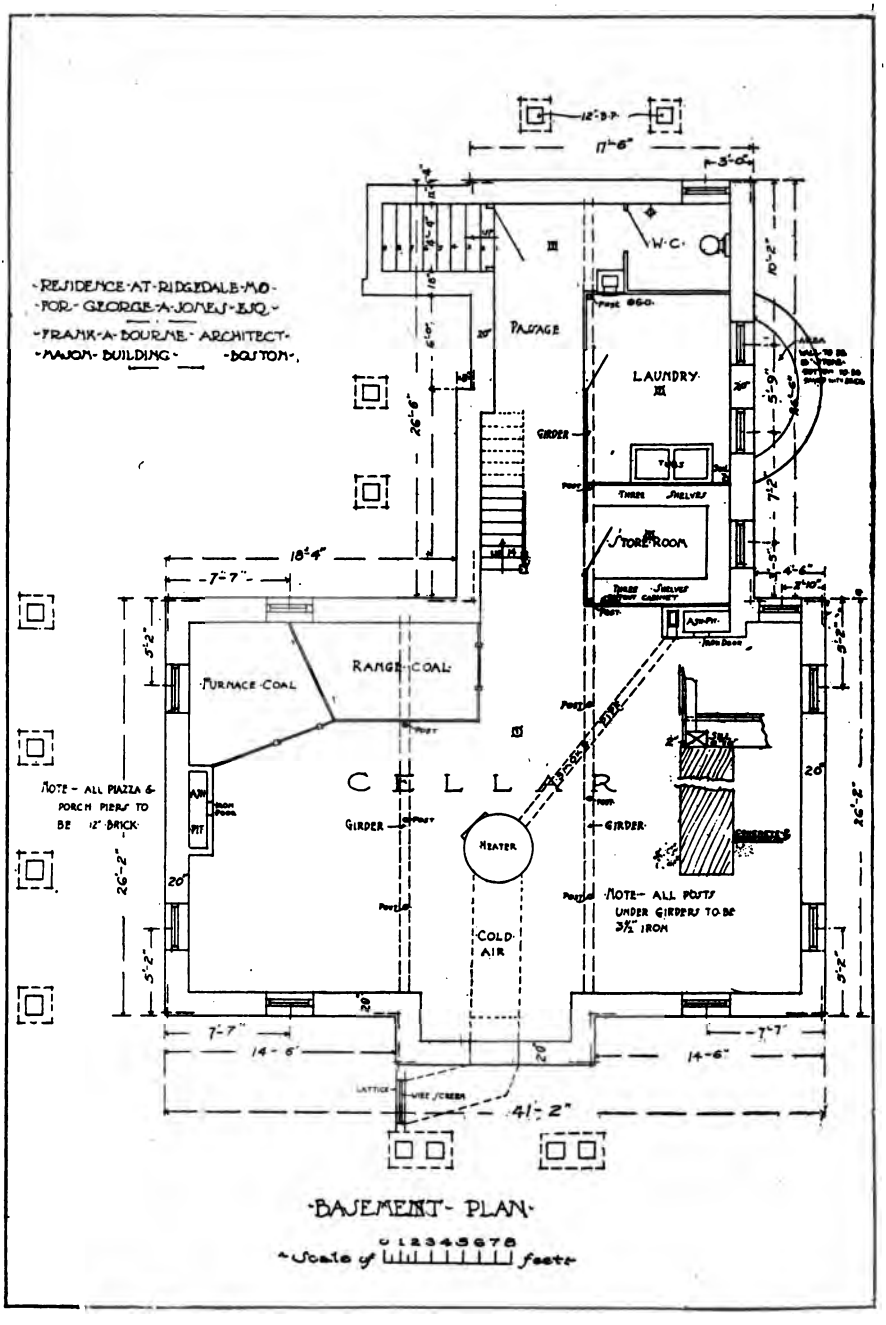


Fig. 20. Basement Plan of the George A. Jones Residence

	Cu. Ft.
Brought forward	480
23 ft. 0 in. × 8 ft. 3 in. × 1 ft. 8 in.	316
12 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in.	132
28 ft. 0 in. × 8 ft. 3 in. × 1 ft. 8 in.	385
6 ft. 0 in. × 6 ft. 7 in. × 1 ft. 6 in.	59
10 ft. 0 in. × 6 ft. 7 in. × 1 ft. 0 in.	66
8 ft. 6 in. × 6 ft. 7 in. × 1 ft. 8 in.	93
9 ft. 0 in. × 8 ft. 3 in. × 1 ft. 8 in.	123
25 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in.	274
6 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in.	66
23 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in.	252
PIERS—	
2 ft. 6 in. × 5 ft. 6 in. × 1 ft. 0 in.	14
2 ft. 6 in. × 5 ft. 6 in. × 1 ft. 0 in.	14
2 ft. 0 in. × 2 ft. 0 in. × 1 ft. 0 in.	4
12 ft. 0 in. × 3 ft. 6 in. × 2 ft. 0 in.	84
12 ft. 0 in. × 3 ft. 6 in. × 2 ft. 0 in.	84
AREA—	
14 ft. 0 in. × 3 ft. 6 in. × 1 ft. 6 in.	73
Total	2,519

2,519 cu. ft. ÷ 25 = 101 perches of mortar wall

UNDERPINNING—	
16 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	45
16 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	45
6 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	17
12 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	34
6 ft. 0 in. × 1 ft. 0 in. × 1 ft. 0 in.	6
8 ft. 6 in. × 1 ft. 8 in. × 1 ft. 8 in.	23
25 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	70
6 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	17
23 ft. 0 in. × 1 ft. 8 in. × 1 ft. 8 in.	64
14 ft. 0 in. × 2 ft. 0 in. × 1 ft. 6 in.	42
Total	363

363 cu. ft. ÷ 25 = 14½ perches of underpinning

Cost of Stonework—

12 perches of dry wall, at $3.50	$42.00
Carried forward	$42.00

Brought forward.....$ 42.00
101 perches of mortar walls, at $5..... 505.00
14½ perches of underpinning, at $8..... 116.00
Total cost of stonework.....$663.00

PLASTERING WALLS WITH CEMENT—
192 ft. 0 in. × 6 ft. 7 in. = 1,264 sq. ft. = 140 sq. yd.
140 sq. yd. at $.50.....$70.00

CESSPOOLS AND DRAINS

LEACHING CESSPOOL—
23 ft. 6 in. × 8 ft. 0 in. × 1 ft. 6 in. = 282 cu. ft. = 11⅓ perches
11⅓ perches at $4.00.....$45.34
Cover..... 2.50 47.84

TIGHT CESSPOOL—
11 ft. 6 in. × 8 ft. 0 in. = 92 sq. ft.
15 bricks × 92 = 1,380 bricks
1,380 bricks at $25 per M.....$34.50
Iron cover..... 3.00 37.50

DRY WELLS—
2 ft. 0 in. × 2 ft. 0 in. × 5 ft. 6 in. × 12 = 264 cu. ft. = 11 perches
11 perches at $3.00..... 33.00

DRAINS—
171 ft. at $.20.....$34.20
14 bends at $.30..... 4.20 38.40
$889.74

BRICKWORK AND FLUE LININGS

NOTE.—Find the number of bricks in a foot of height in each chimney or pier, reckoning five courses to the foot of height.

CELLAR—

	No. BRICKS
35 × 8.....	280
107½ × 8.....	860
55 × 8.....	440
Carried forward.....	1,580

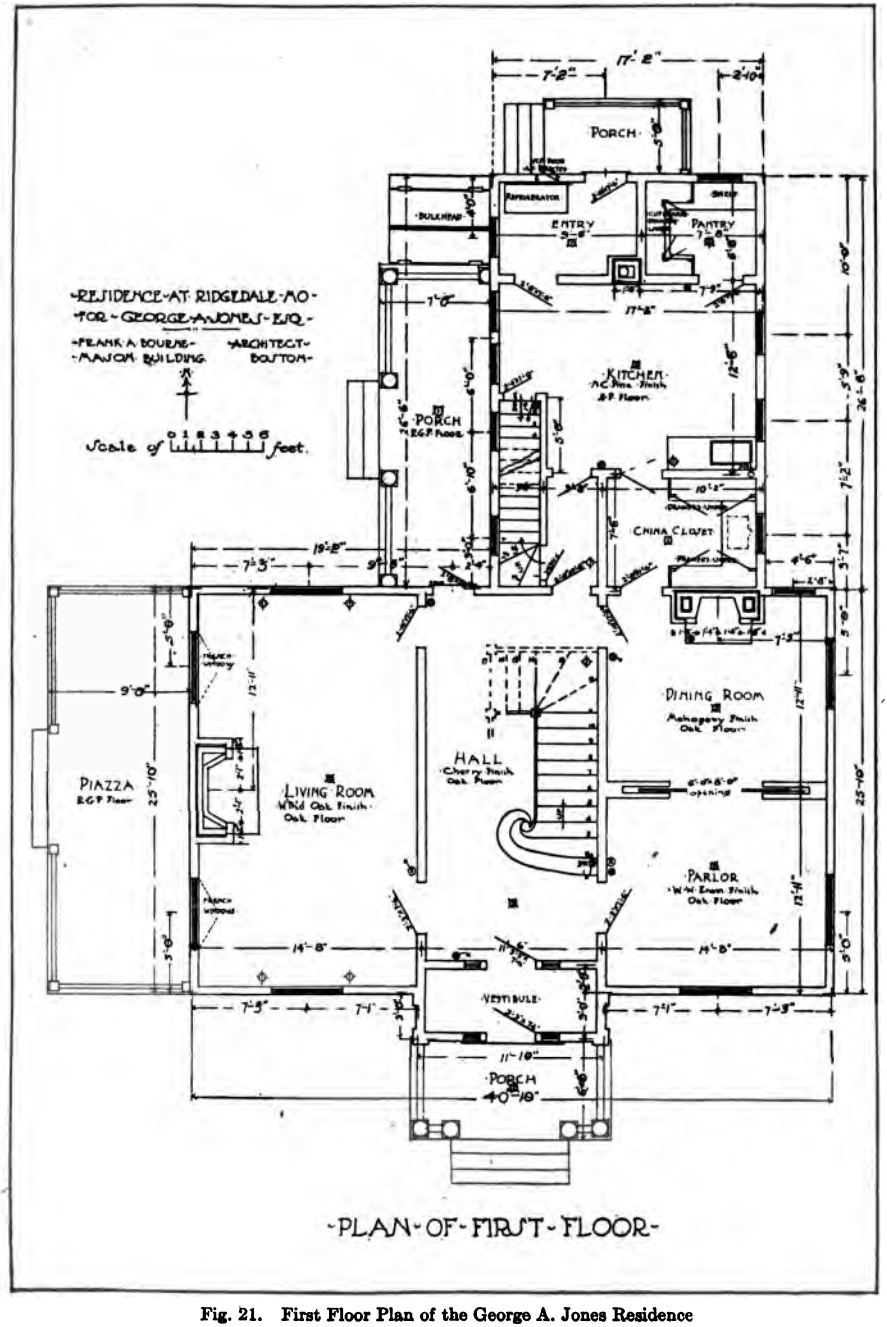


Fig. 21. First Floor Plan of the George A. Jones Residence

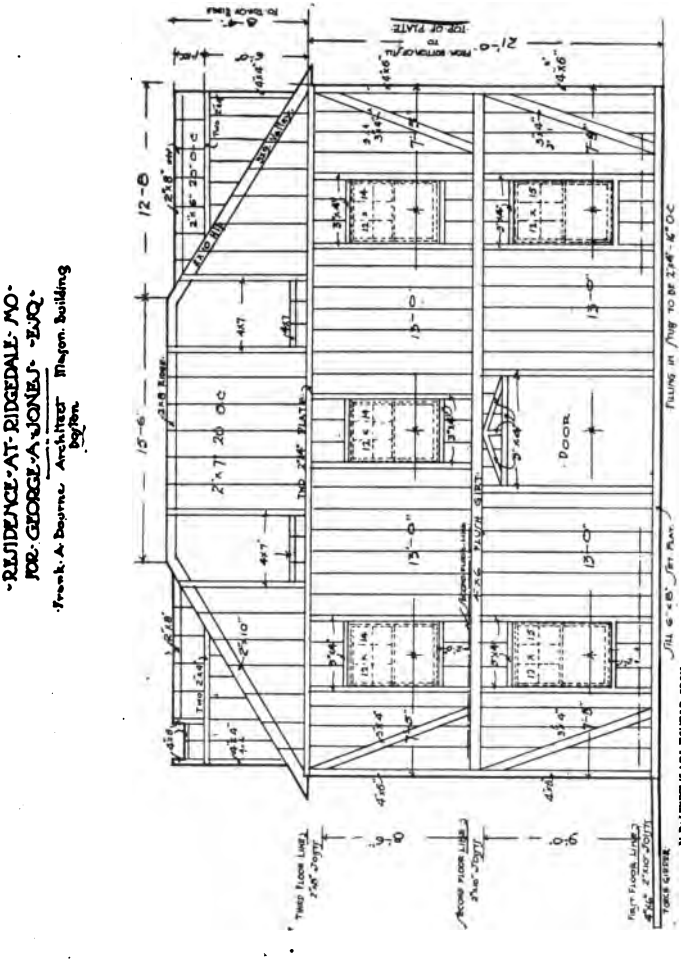


Fig. 22. Framing of Front Elevation of the George A. Jones Residence

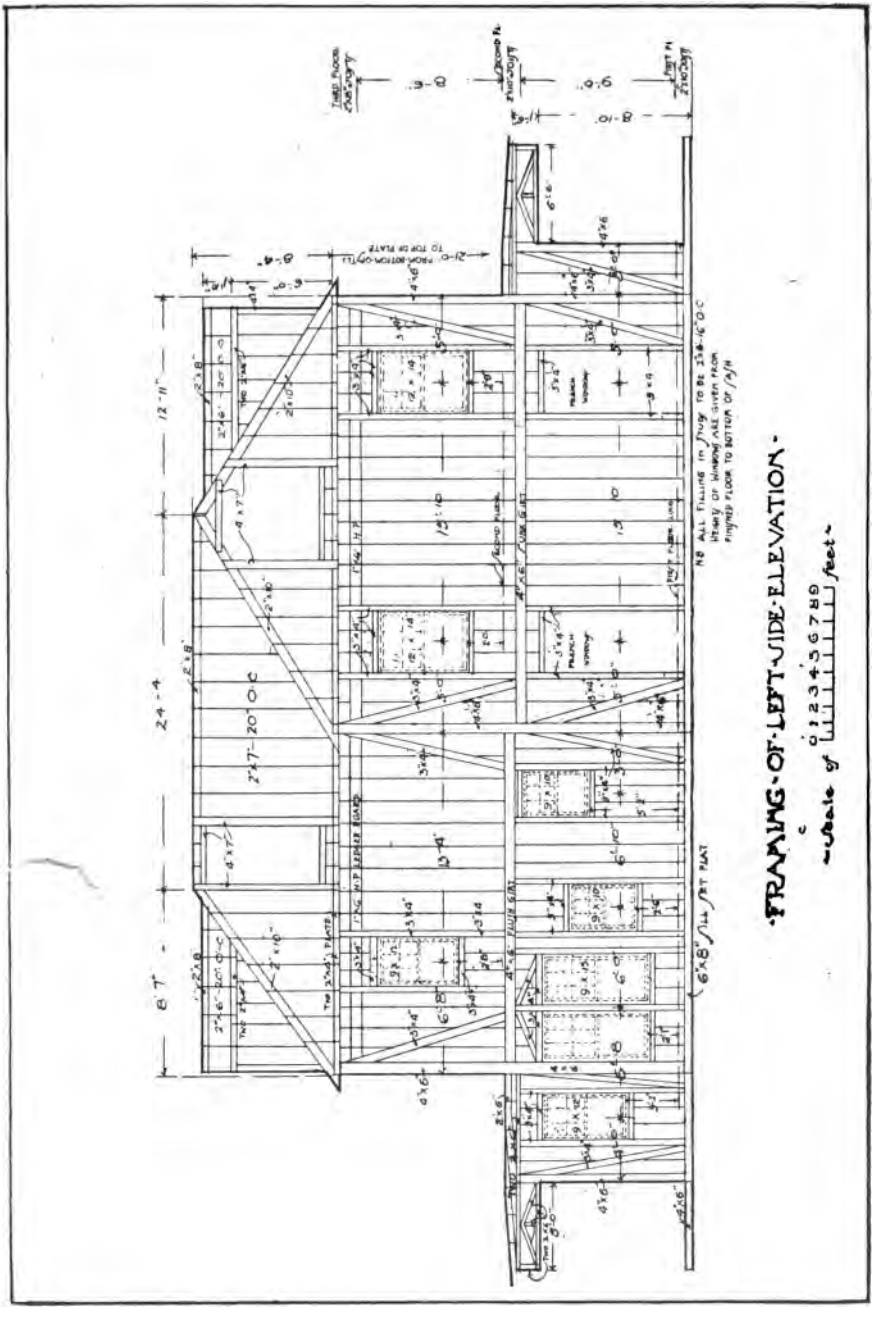


Fig. 23. Framing of Left Side Elevation of the George A. Jones Residence

	No. Bricks
Brought forward	1,580
VERANDA PIERS—	
58½ × 10	585
CHIMNEYS—	
107½ × 6 ft. 6 in	700
105 × 11 ft. 0 in	1,155
35 × 11 ft. 0 in	385
35 × 4 ft. 6 in	157
127½ × 5 ft. 6 in	701
35 × 19 ft. 0 in	665
57½ × 4 ft. 0 in	230
127½ × 11 ft. 0 in	1,402
Total	7,560

Cost of Brickwork—

7,560 bricks at $25 per M., laid		$189.00
3 fireplaces at $40 each		120.00
1 flue lining 26 ft. 13 in. × 13 in., at $.28	$ 7.28	
1 flue lining 36 ft. 9 in. round, at $.22	7.92	
1 flue lining 68 ft. 8½ in. × 13 in., at $.22	14.96	
		30.16
Total		$339.16

CONCRETING

	Sq. Ft.
23 ft. 0 in. × 38 ft. 0 in	874
3 ft. 0 in. × 9 ft. 6 in	28½
15 ft. 0 in. × 26 ft. 0 in	390
4 ft. 0 in. × 7 ft. 0 in	28
Total	1,320
1,320 sq. ft. (147 sq. yd.) at $.75	$110.25

PLASTERING

NOTE.—Take off square feet of plastered surfaces, and deduct one-half of the openings, after reducing to square yards.

CELLAR—	Sq. Ft.
23 ft. 0 in. × 38 ft. 0 in	874
9 ft. 6 in. × 3 ft. 0 in	28
Carried forward	902

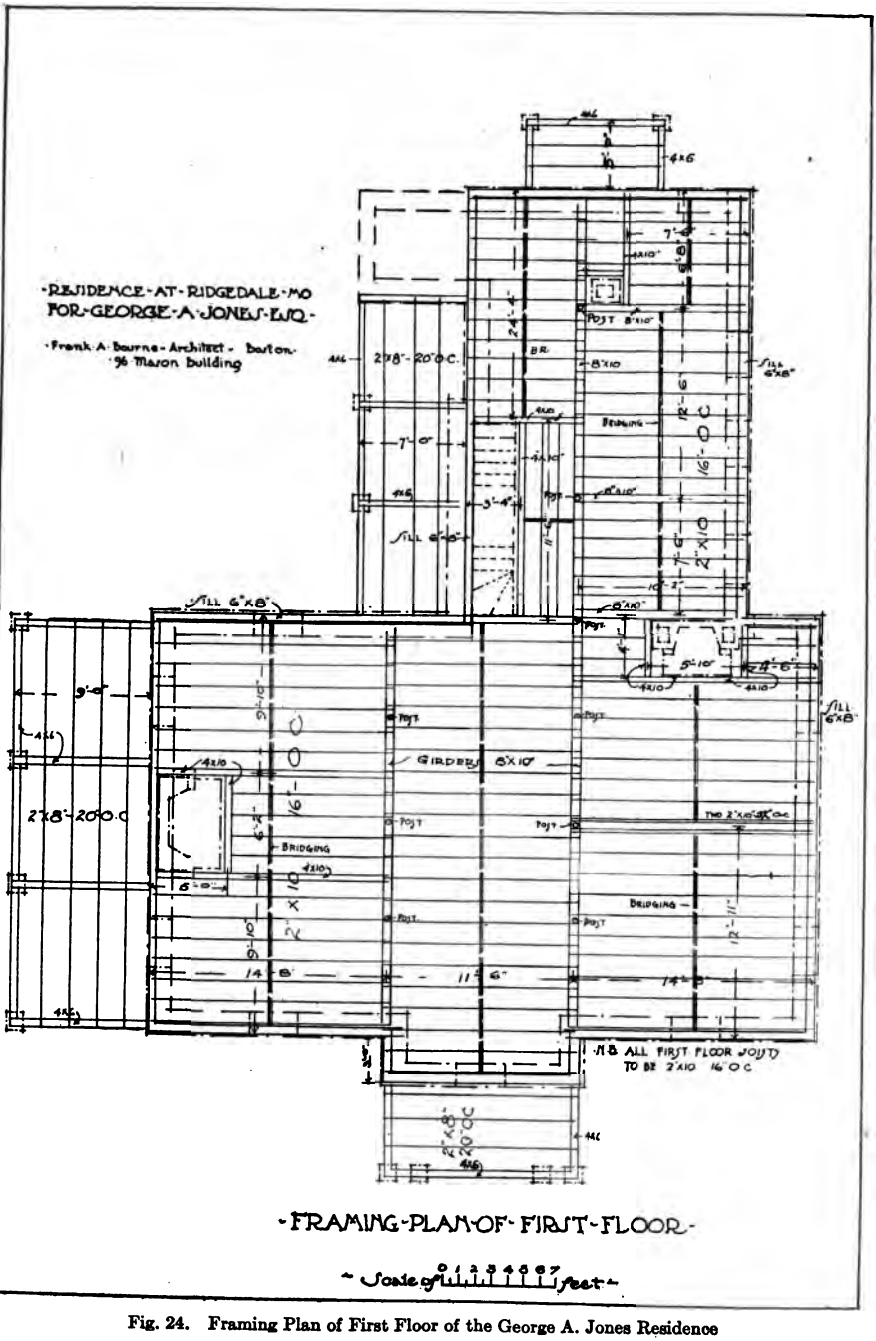


Fig. 24. Framing Plan of First Floor of the George A. Jones Residence

	Sq. Ft.
Brought forward	902
15 ft. 6 in. × 26 ft. 0 in.	403
30 ft. 0 in. × 8 ft. 0 in.	240
FIRST STORY—	
25 ft. 0 in. × 40 ft. 0 in.	1,000
11 ft. 0 in. × 3 ft. 0 in.	33
25 ft. 6 in. × 16 ft. 6 in.	420
490 ft. 0 in. × 9 ft. 0 in.	4,410
SECOND STORY—	
25 ft. 0 in. × 40 ft. 0 in.	1,000
16 ft. 6 in. × 19 ft. 0 in.	313
520 ft. 0 in. × 8 ft. 6 in.	4,420
Total surface	13,141
OUTS—	
32 doors, average 40 sq. ft.	1,280
34 windows, average 15 sq. ft.	510
	1,790

1,790 sq. ft. ÷ 2 = 895 sq. ft. allowance for outs

13,141 sq. ft. − 895 sq. ft. = 12,246 sq. ft. = 1,361 sq. yd.

Cost of Plastering—

1,361 sq. yd. at $.48 ..... $653.28

CARPENTER WORK*

FRAME—	Ft. B. M.
188 linear ft. 6 × 6 in. sill	564
136 linear ft. 4 × 6 in. sill	272
74 linear ft. 8 × 10 in. girders	494
250 linear ft. 4 × 6 in. posts	500
188 linear ft. 4 × 6 in. girts	376
	2,206

2,206 ft. B. M. at $43 per M $94.86

FIRST-STORY FRAME, BRIDGING, AND UNDER FLOOR—

25 ft. 0 in. × 40 ft. 0 in. 1,000

Carried forward $94.86

* See "Analysis of Carpenter Work."

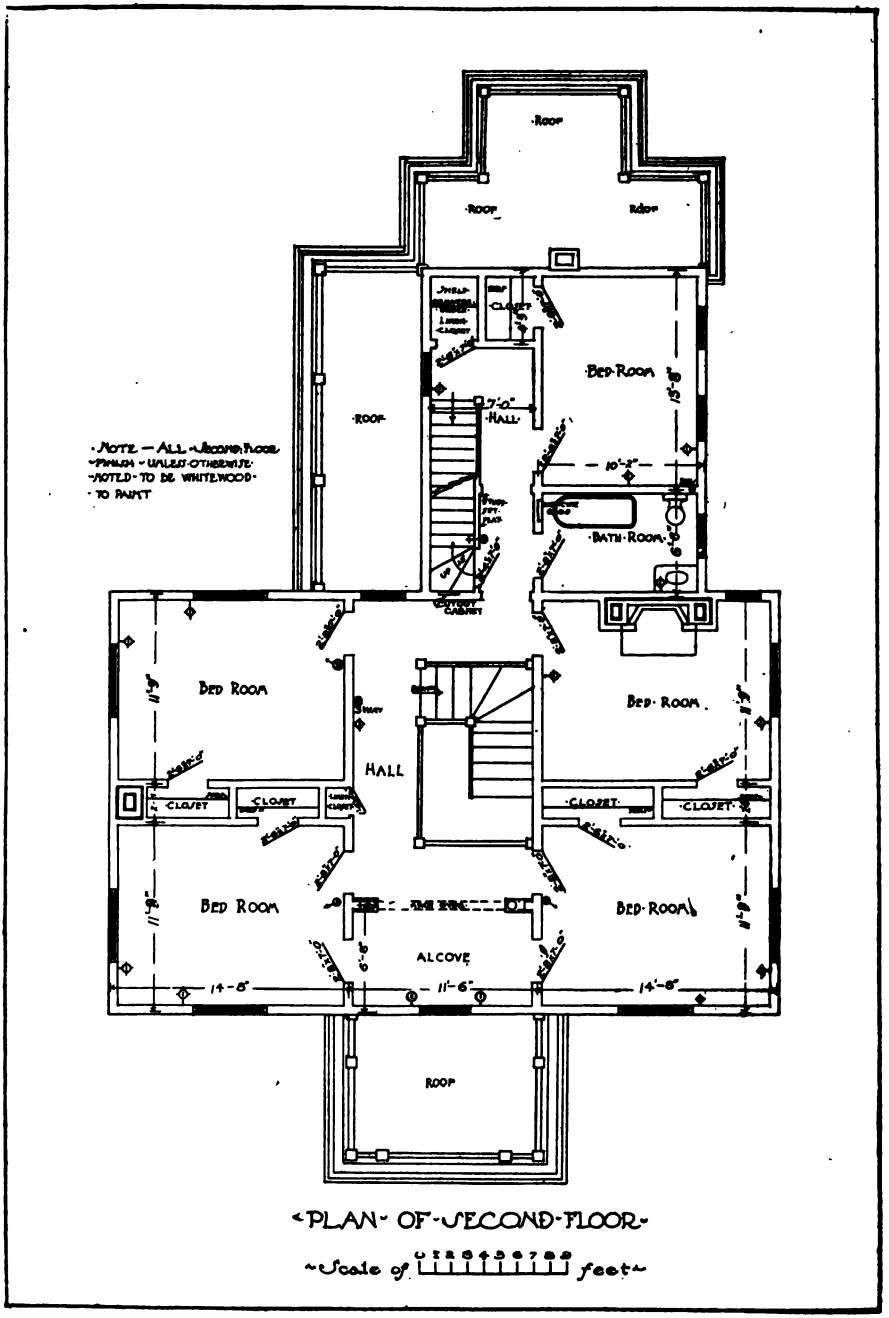


Fig. 25. Second Floor Plan of the George A. Jones Residence

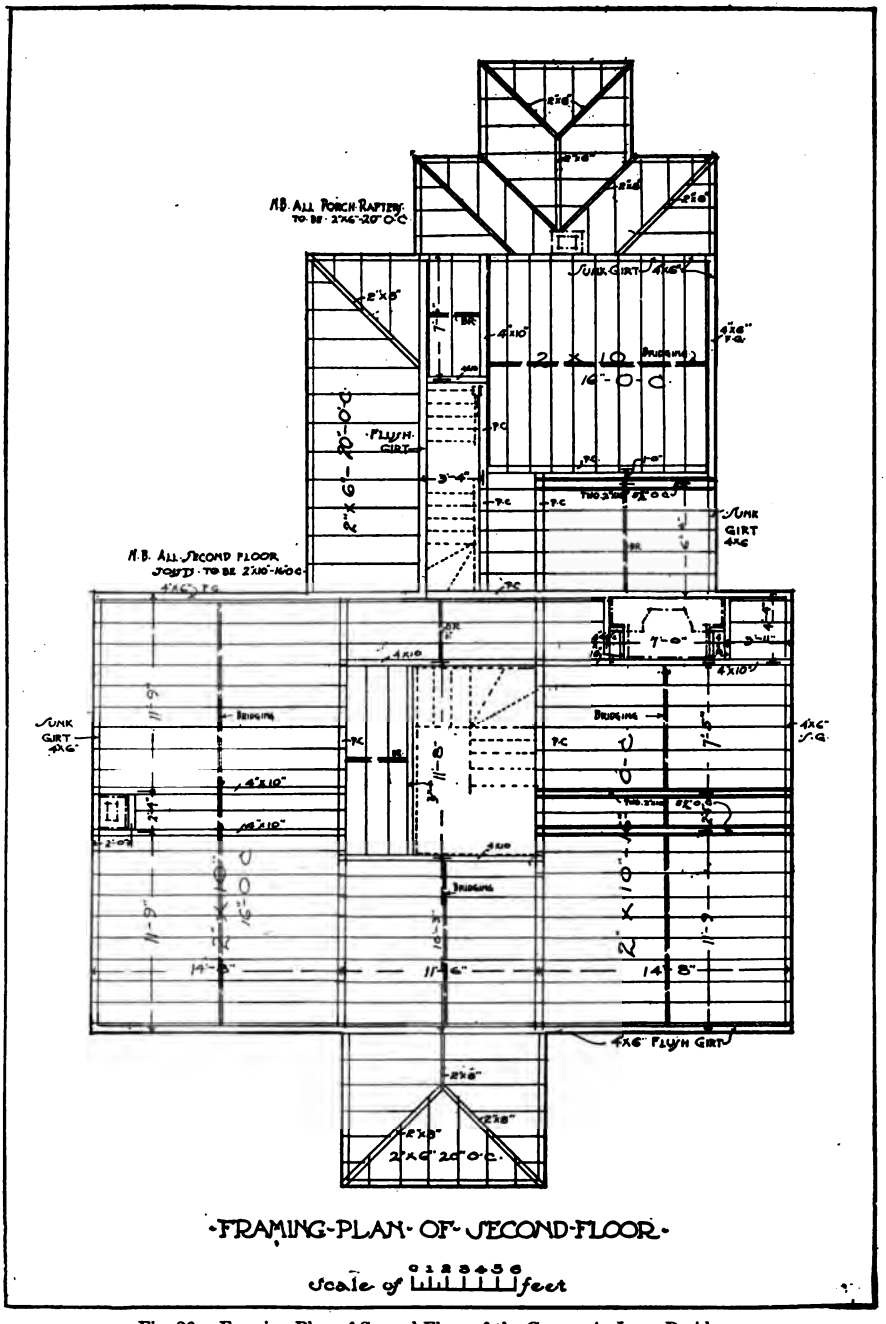


Fig. 26. Framing Plan of Second Floor of the George A. Jones Residence

Brought forward.....$94.86

	Sq. Ft.
11 ft. 0 in. × 3 ft. 0 in.	33
26 ft. 0 in. × 16 ft. 6 in.	429
	1,462

1,462 sq. ft. (14.62 squares) at $10.66 per square.....$155.85

UPPER FLOOR—

Hard Pine

25 ft. 6 in. × 16 ft. 6 in.	421

421 sq. ft. (4.21 squares) at $13.25 per square.....$55.78

Oak

25 ft. 0 in. × 40 ft. 0 in.	1,000
11 ft. 0 in. × 3 ft. 0 in.	33
	1,033

1,033 sq. ft. at $26.25 per square.....$271.10

PORCH FLOOR—

6 ft. 0 in. × 11 ft. 0 in.	66
9 ft. 0 in. × 5 ft. 0 in.	45

PIAZZA FLOOR—

26 ft. 0 in. × 9 ft. 0 in.	234
20 ft. 6 in. × 7 ft. 0 in.	144
	489

489 sq. ft. at $14.65 per square.....$71.63

SECOND-STORY FRAME, BRIDGING, AND STRAPPING FLOORS—

40 ft. 0 in. × 25 ft. 0 in.	1,000
20 ft. 0 in. × 17 ft. 0 in.	340
	1,340

1,340 sq. ft. at $27.26 per square.....$373.40

THIRD STORY—

1,340 sq. ft. at $11.83 per square.....$258.52

ROOF FRAME, BOARDING, AND SHINGLES—

30 ft. 0 in. × 16 ft. 6 in. × 2 (sides)	990
34 ft. 0 in. × 16 ft. 6 in. × 2 (sides)	1,122
	2,112

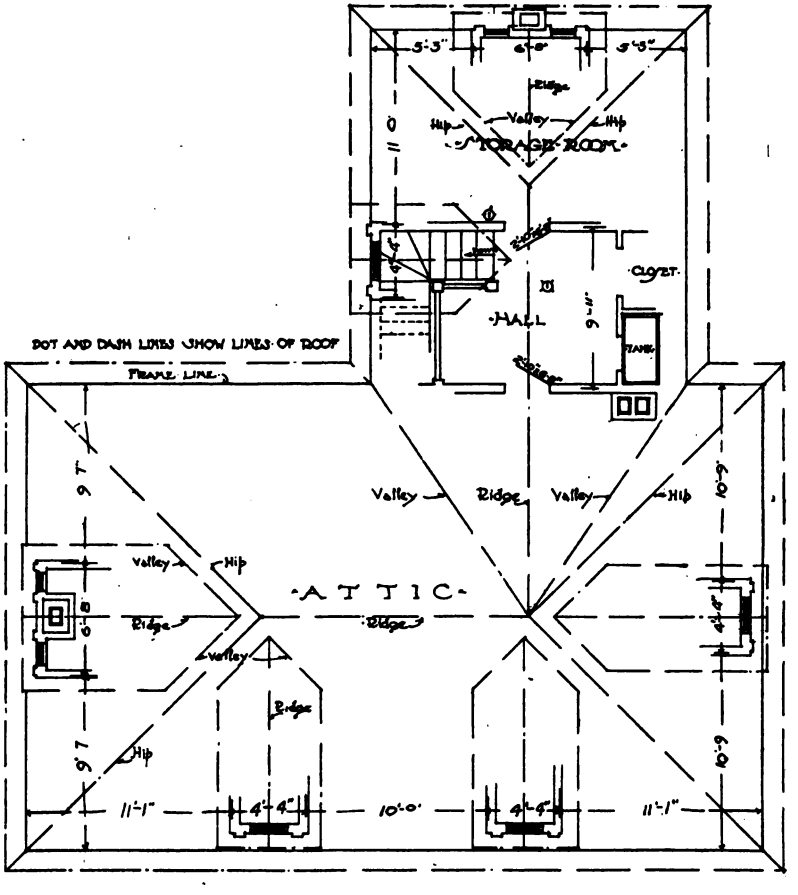
2,112 sq. ft. at $17.65 per square.....$373.40

FLASHING—*Cost*..... 50.00

TIN ROOF, FRAME AND BOARDING—

21 ft. 0 in. × 7 ft. 6 in.	157

Carried forward.....$1,704.54



PLAN OF THIRD FLOOR & ROOF

Scale of 0 1 2 3 4 5 6 7 8 feet

Fig. 27. Third Floor and Roof Plan of the George A. Jones Residence

Brought forward.....$1,704.54

	Cu. Ft.
19 ft. 0 in. × 6 ft. 6 in.....	124
11 ft. 0 in. × 5 ft. 6 in.....	60
14 ft. 0 in. × 9 ft. 6 in.....	133
	474

474 sq. ft. at $22.10 per square.....$104.75

OUTSIDE WALLS, STUDDING AND BOARDING—

172 ft. 0 in. × 20 ft. 0 in.....	3,440
6 ft. 6 in. × 10 ft. 0 in. × 2 (sides).....	130
3 ft. 0 in. × 9 ft. 0 in. × 2 (sides).....	54
	3,624

3,624 sq. ft. at $9.31 per square.....$347.39

INSIDE STUDDING—

180 ft. 0 in. × 9 ft. 0 in.....	1,620
196 ft. 0 in. × 8 ft. 6 in.....	1,666
28 ft. 0 in. × 8 ft. 0 in.....	224
	3,510

3,510 sq. ft., at $5 per square.....$165.50

CLAPBOARDING—

44 ft. 0 in. × 19 ft. 0 in. × 2 (sides).....	1,672
6 ft. 0 in. × 8 ft. 0 in. × 2 (sides).....	96
2 ft. 0 in. × 9 ft. 0 in. × 2 (sides).....	36
39 ft. 0 in. × 19 ft. 0 in. × 2 (sides).....	1,482
	3,286

3,286 sq. ft. at $10.46 per square.....$343.72

Deduct for stock only, 36 windows
= 540 sq. ft., at $5.90 per square.... 31.86 $311.86

Miscellaneous

DORMERS—

6, at $50 each.....$300.00

MAIN CORNICE—

180 ft., at $1.50 per ft..... 270.00

BALUSTRADE ON ROOF—

96 ft., at $0.50 per ft.....	$48.00	
18 posts, at $1.50 each.....	27.00	75.00

Carried forward.....$3,279.04

Brought forward		$3,279.04
PIAZZA FINISH—		
Cornice—		
102 ft., at $2		$204.00
Columns—		
9 in place, at $11 each		99.00
Corner Pilasters—		
2½ in place, at $9 each		22.50
Balustrade—		
76 ft., at $.50	$38.00	
8½ small posts at $1 each	12.00	50.00
Outside Steps		25.00
Lattice—		
55 ft. 0 in. × 1 ft. 6 in. = 82½ sq. ft., at $.15		12.37
Porch Ceiling—		
111 sq. ft., at $10 per square		11.10
BULKHEAD STEPS		25.00
CORNER BOARDS—		
252 ft. 0 in. × 8 in. = 168 sq. ft., at $.30 per sq. ft.		50.40
WATER TABLE—		
117½ linear ft., at $.20		23.50
WINDOWS AND FRAMES—		
Attic—		
4 windows, circular top, at $11.20		44.80
4 windows, square, at $5.25		21.00
Second Story—		
8 windows, 3 ft. 6 in. × 5 ft. 0 in., at $10.63		85.04
7 windows, 2 ft. 6 in. × 4 ft. 6 in., at $10.00		70.00
First Story—		
1 window, 2 ft. 6 in. × 4 ft. 6 in.		10.00
2 windows, 2 ft. 6 in. × 5 ft. 6 in., at $10.50		21.00
2 windows, 2 ft. 6 in. × 3 ft. 9 in., at $9.00		18.00
2 pairs French windows (oak) 4 ft. 6 in. × 7 ft. 6 in., at $18.24		36.48
1 window, 3 ft. 4 in. × 5 ft. 6 in. (oak finish)		16.18
Carried forward		$4,124.41

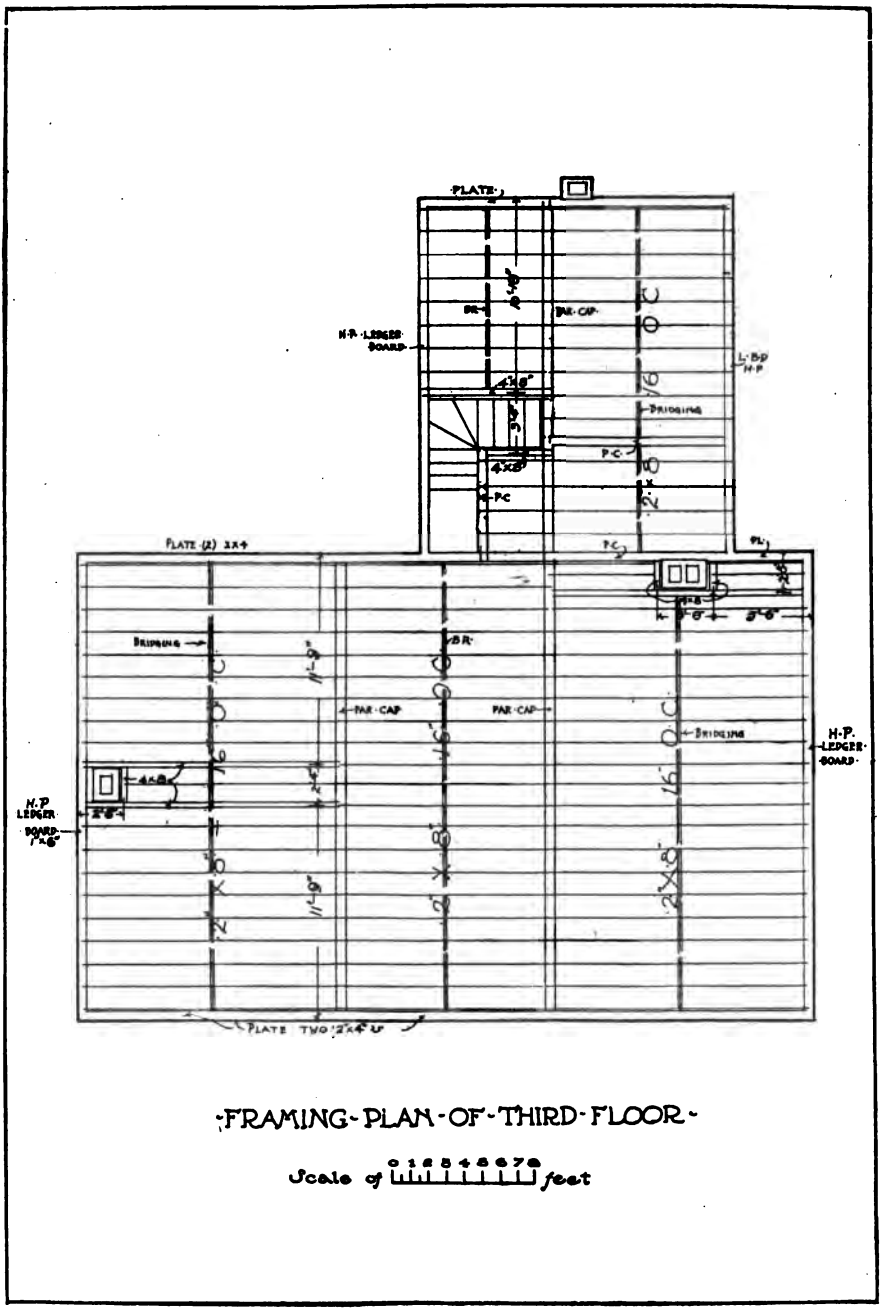
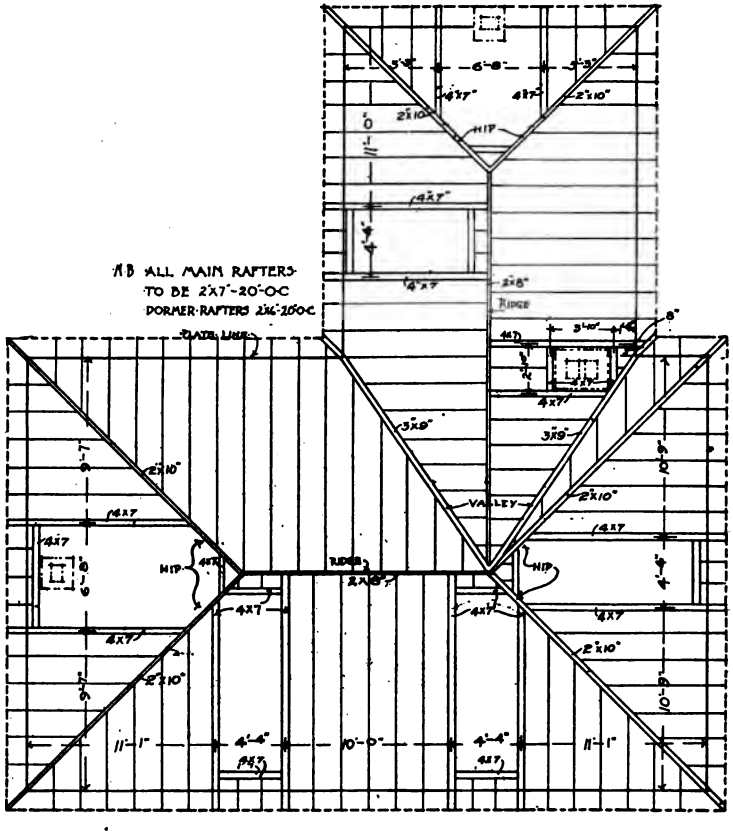


Fig. 28. Framing Plan of Third Floor of the George A. Jones Residence

Brought forward		$4,124.41
1 window, 3 ft. 4 in. × 5 ft. 6 in. (birch finish)		16.18
1 window, 2 ft. 6 in. × 5 ft. 6 in. (birch finish)		14.45
2 windows, 3 ft. 4 in. × 5 ft. 5 in. (whitewood), at $10.10		20.20
4 windows, 2 ft. 6 in. × 4 ft. 6 in. (N.C. pine), at $9.40		37.60
FRONT DOOR, with side and top lights—		
3 ft. 3 in. × 7 ft. 6 in		56.33
REAR DOOR—		
2 ft. 10 in. × 7 ft. 6 in		13.46
CELLAR SASHES—		
12, at $3.25		39.00
COAL BINS IN BASEMENT—		
240 sq. ft. studding at $3.00 per square	$ 7.20	
240 sq. ft. boarding at $4.75 per square	13.08	
2 days' labor on one door	4.56	24.84
COLD-AIR BOX—		
3 ft. 0 in. × 1 ft. 0 in., 25 ft. long, at $.62 per linear ft.		15.50
BASEMENT PARTITIONS—		
46 ft. 0 in. × 8 ft. 0 in., 368 sq. ft., at $10.20 per square		37.53
3 doors, at $9.53		28.59
67½ ft. shelving		10.12
1 door to bulkhead		10.00
FIRST STORY—		
1 door, 2 ft. 8 in. × 7 ft. 6 in. (whitewood and birch finish)		20.67
1 pair sliding doors (whitewood and birch finish)		53.52
40 ft. birch base		8.00
1 door, 3 ft. 3 in. × 7 ft. 6 in. (whitewood and oak)		22.67
1 door, 2 ft. 10 in. × 7 ft. 6 in. (whitewood and oak)		20.67
WOOD CORNICE IN DINING ROOM—		
56 ft. 6 in. × 6 in. birch, at $.48	$26.88	
56 ft. picture molding, at $.06	3.36	30.24
WOOD CORNICE IN LIBRARY—		
82 ft. 6 in. × 6 in. oak, at $.48	$39.36	
Carried forward	$39.36	$4,603.98

Brought forward	$39.36	$4,603.98
82 ft. picture molding, at $.06	4.92	44.28
OAK BASE—		
72 ft., at $.20		14.40
1 door, 3 ft. 0 in. × 7 ft. 6 in. (whitewood)		12.59
VESTIBULE DOOR, side lights and top light, same as front door		56.33
WHITEWOOD BASE, 101 ft., at $.10		10.10
5 doors (N. C. pine), at $9.48		47.40
CHINA CLOSET FINISH		100.00
PANTRY		50.00
KITCHEN AND BACK ENTRY SHEATHING—		
65 linear ft., at $.40		26.00
MANTELS—		
Allowance	$125.00	
Labor of setting	6.50	131.50
SECOND STORY—		
16 doors stock, at $9.48		151.68
1 arch in hall		10.00
2 wood columns, at $10		20.00
5 closets, at $3.50		17.50
1 linen closet		25.00
1 linen closet		20.00
THIRD STORY—		
2 doors, finished one side, at $7.04 each		14.08
1 closet door		7.04
Tank		10.00
Finished floor, 100 sq. ft		7.25
Base, 14 ft., at $.10		1.40
CONDUCTORS—		
120 ft., at $.15 per ft., put up	$18.00	
6 goosenecks, at $1.00	6.00	24.00
CUTTING AND FITTING FOR PLUMBING AND HEATING		35.00
FREIGHT, FARES, AND EXPENSES		50.00
INSURANCE		10.00
Total cost of carpenter work		$5,499.53



FRAMING PLAN OF ROOF

Scale of 0 1 2 3 4 5 6 7 8 feet.

Fig. 29. Framing Plan of Roof of the George A. Jones Residence

STAIRS

FRONT STAIRS—

128 ft. spruce, at $32 per M	$ 4.10	
120 ft. whitewood, at $82 per M	9.84	
85 ft. quartered oak, at $150 per M	12.75	
30 ft. mahogany rail and turn	40.00	
5 paneled posts at $5.00	25.00	
105 balusters, at $.20	21.00	
11 nosings, at $.06	.66	
25 scotias, at $.03	.75	
Nails, glue, etc	1.00	
Labor	76.00	$193.10

BACK STAIRS—

First Flight—

55 ft. spruce, at $32 per M	$ 1.76	
105 ft. N. C. pine, at $60 per M	6.30	
16 scotias, at $.03 each	.48	
Nails, etc	.75	
Labor	22.00	31.27

Second Flight—

54 ft. spruce, at $32 per M	$ 1.73	
110 ft. N. C. pine, at $60 per M	6.60	
17 scotias, at $.03 each	.51	
Nails, etc	.75	
1 post	1.00	
4 ft. rail, at $.12½	.50	
12 balusters, at $.08	.96	
Labor	24.00	36.05

CELLAR STAIRS—

40 ft. spruce, at $32 per M	$1.28	
75 ft. N. C. pine, at $60 per M	4.50	
Post	.75	
Rail	1.20	
Labor	7.00	14.73
		$275.15
Teaming		2.00
Total cost of stairs		$277.15

HARDWARE

NOTE.—This estimate is based upon a fair quality of hardware, the butts being of bronze-plated steel, the knobs of glass in Master's part, with rose and escutcheon of bronze; the sash fasts of solid bronze metal, also lifts and catches; black or white knobs in service portion.

Basement

BULKHEAD, OUTSIDE—		
2 pairs extra heavy galvanized T-hinges, 8-in., at $.85	$1.70	
2 hooks and staples, 5-in., at $10.00	.20	
Labor	1.00	
BULKHEAD, INSIDE—		
1 pair heavy T-hinges, 8-in	.15	
1 thumb latch	.10	
Labor	.50	
THREE DOORS—		
3 pairs butts, 3½-× 3½-in., at $.20	.60	
3 sets locks at $.50	1.50	
Labor	2.00	
HINGED WINDOWS—		
12 pairs butts, 1¼-in., at $.08	.96	
12 hooks and eyes, at $.04	.48	
12 buttons, at $.04	.48	
Labor	2.00	$11.67

First Floor

ENTRANCE DOOR—		
1½ pairs butts, 4½- × 4½-in., at $.50	$ 0.75	
1 set locks, bronze metal	12.00	
Labor	2.50	
SEVEN INSIDE DOORS, FRONT—		
7 pairs butts, 3½- × 3½-in., at $.40	2.80	
7 sets locks, at $1.50	10.50	
Labor	7.00	
Carried forward	$35.55	$11.67

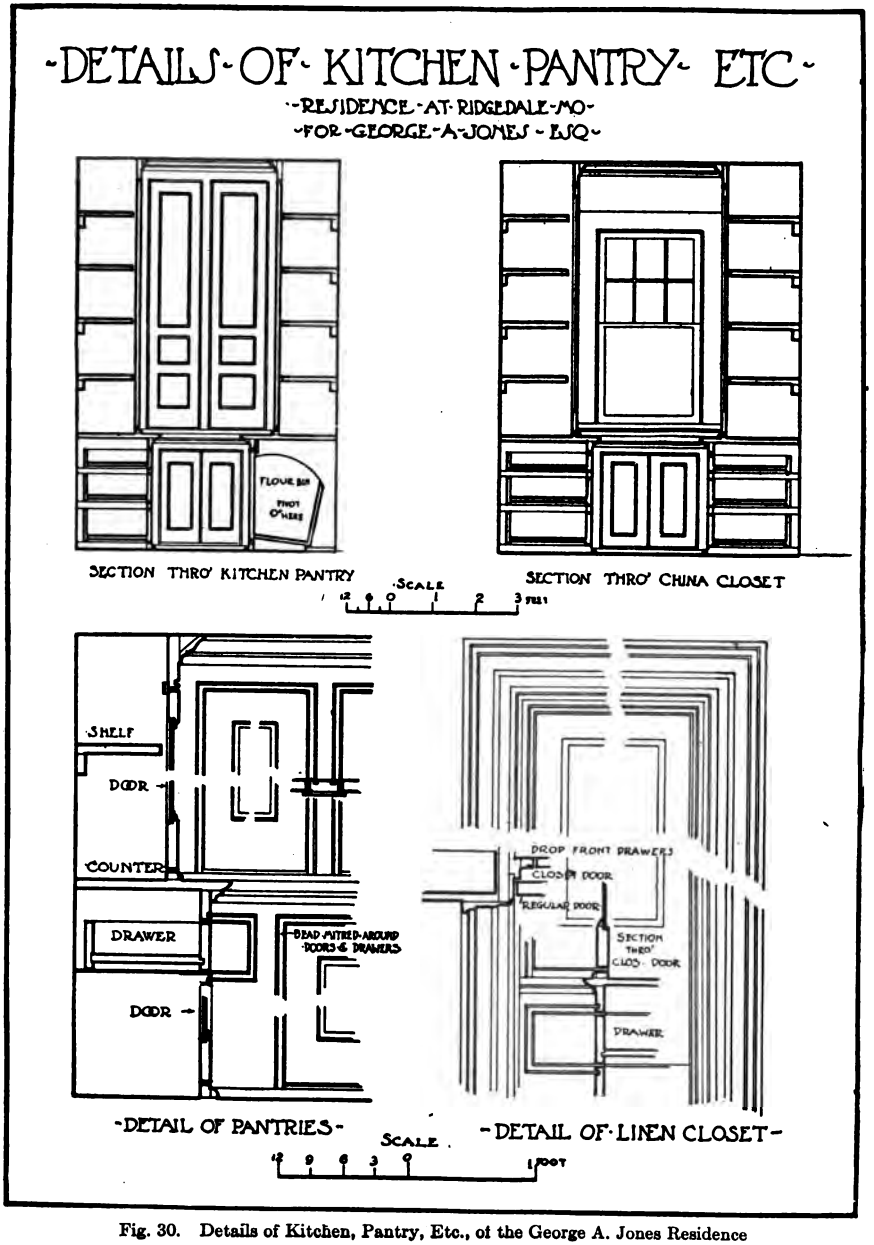


Fig. 30. Details of Kitchen, Pantry, Etc., of the George A. Jones Residence

Brought forward	$35.55	$11.67
SIDE ENTRANCE DOOR—		
1½ pairs butts, 4½- × 4½-in. at $.50	.75	
1 set locks	3.00	
Labor	1.25	
ONE PAIR SLIDING DOORS, 5 ft. 0 in.		
1 set hangers, 5 ft. 0 in. double	4.50	
1 set S. D. locks	3.00	
Labor	2.50	
SIX INSIDE BACK PORTIONS—		
6 sets locks, at $.60	3.60	
6 pairs butts, 3½- × 3½-in. at $.20	1.20	
Labor	5.00	
BACK DOORS—		
1½ pairs butts, 4½- × 4½-in. at $.30	.45	
1 set locks	3.00	
Labor	1.25	
ICE CHEST DOOR—		
1 pair butts, 3- × 3-in.	.50	
1 IH lever, galvanized	.75	
1 brass hasp and padlock	2.00	
Labor	.75	
CHINA CLOSET—		
2 pairs glass doors—		
2 pairs butts, 2½- × 2½-in. at $.30	.60	
2 elbow catches, at $.10	.20	
2 cupboard catches, at $.15	.30	
1 pair cupboard doors—		
2 pairs butts, 2½- × 2½-in. at $.15	.30	
1 elbow catch	.10	
1 cupboard catch	.15	
20 drawer pulls, at $.10	2.00	
Labor	3.50	
PANTRY—		
4 cupboard doors—		
4 pairs butts, 2½- × 2½-in. at $.15	.60	
Carried forward	$76.15	$11.67

Brought forward	$76.15	$11.67
4 cupboard catches, at $.15	.60	
1 bbl. swing	.75	
10 drawer pulls, at $.10	1.00	
Labor	2.50	
WINDOWS—		
15 sash fasts, at $.40	6.00	
30 sash lifts, at $.10	3.00	
Labor	10.00	
CASEMENT WINDOWS—		
4 pairs butts, 3- × 3-in. at $.50	2.00	
2 pairs flush bolts, at $1.00	2.00	
2 casement fasts, at $.60	1.20	
Labor	1.25	96.45
Second Floor		
SIXTEEN DOORS—		
16 pairs butts, 3½- × 3½-in., at $.40	$ 6.40	
16 sets locks, at $1.00	16.00	
Labor	13.50	
WINDOWS—		
14 sash fasts, at $.40	5.60	
1 sash fast	.50	
28 sash lifts, at $.10	2.80	
2 sash lifts, at $.12	.24	
Labor	9.50	
SIX DRAWERS IN LINEN CLOSET—		
12 drawer pulls, at $.10	1.20	
Labor	.25	55.99
BATHROOM—		
1 pair butts, 3½- × 3½-in. (nickel-plate)	$0.50	
1 set locks (nickel-plate)	1.50	
Labor	1.00	3.00
Attic		
TWO DOORS—		
2 pairs butts, 3½- × 3½-in., at $.12	$0.24	
2 sets locks, at $.60	1.20	
Labor	1.25	
Carried forward	$2.69	$167.21

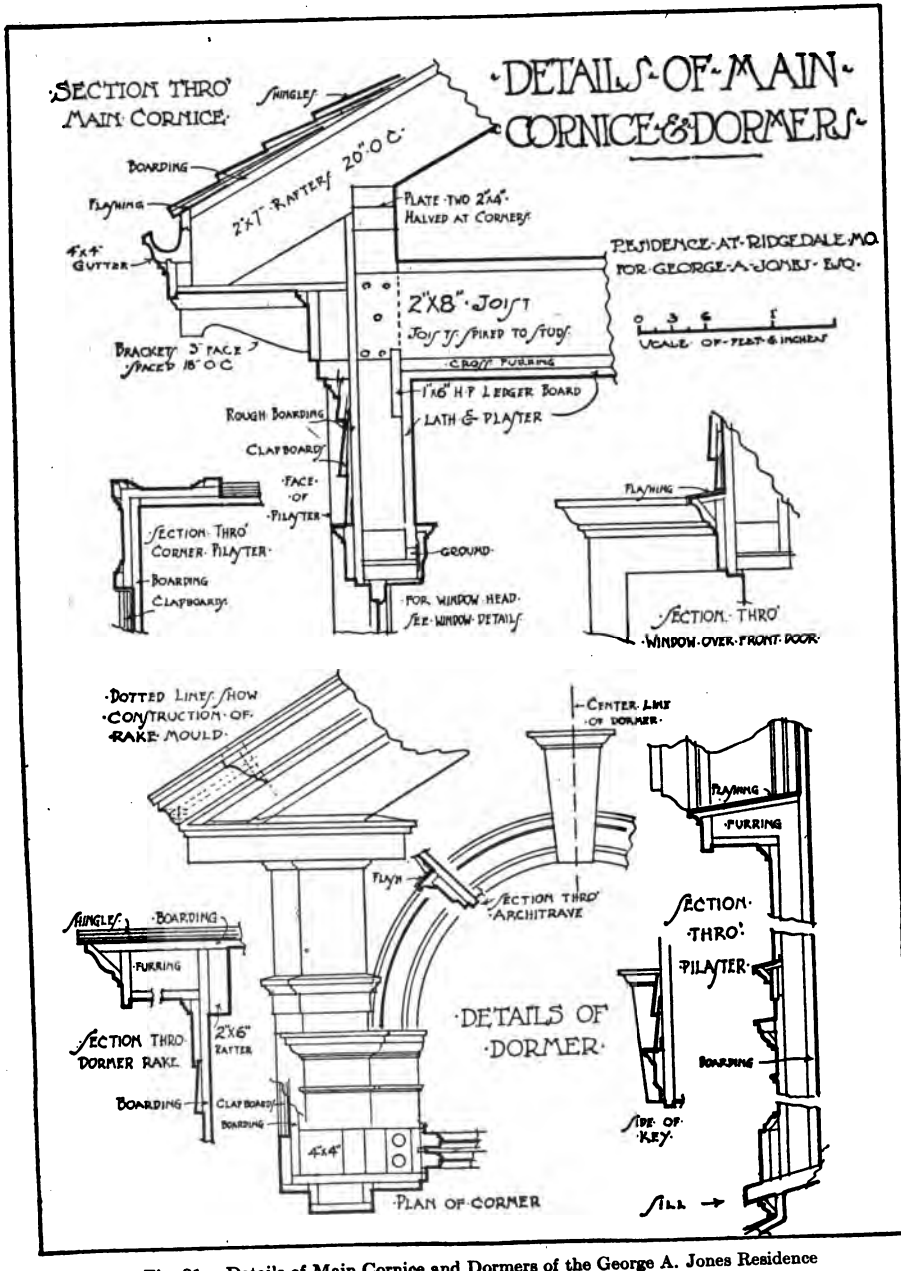


Fig. 31. Details of Main Cornice and Dormers of the George A. Jones Residence

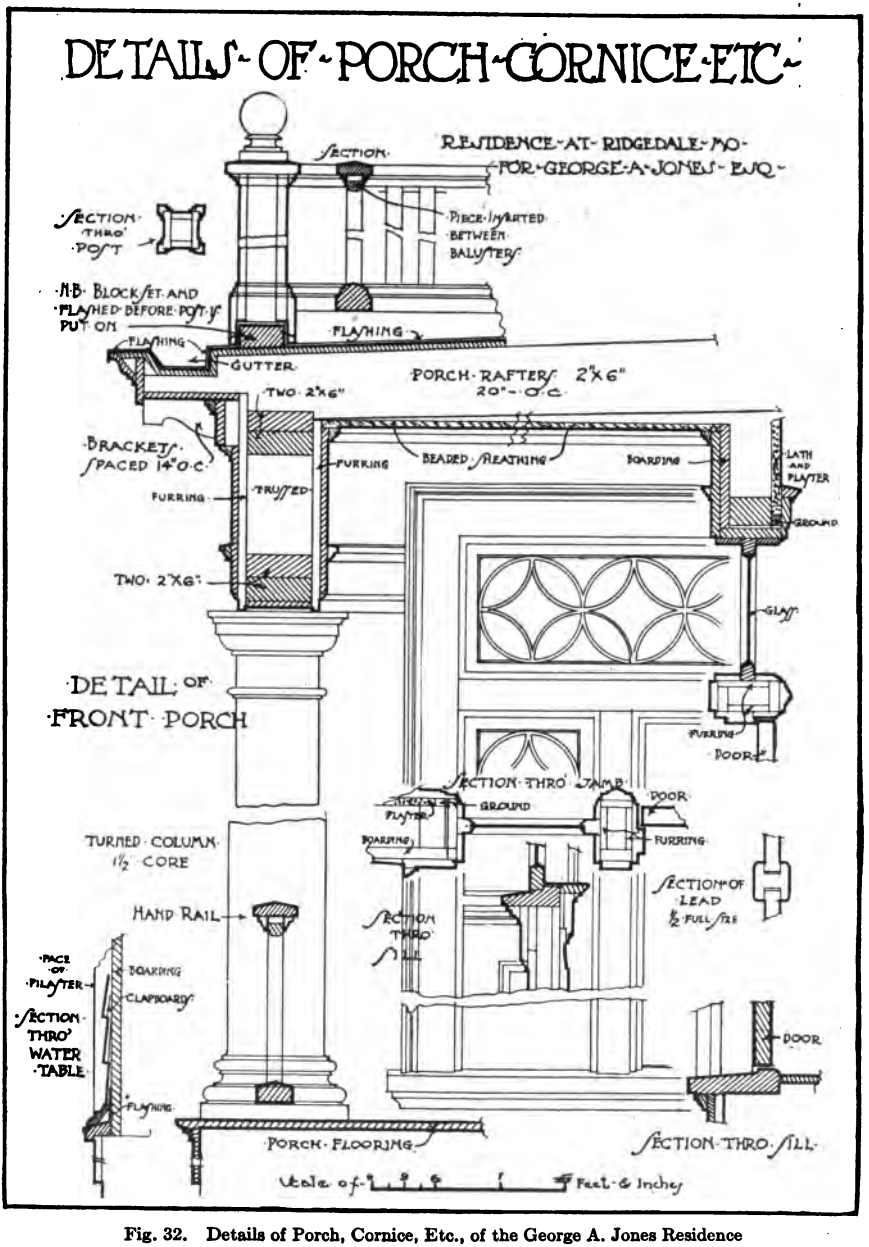


Fig. 32. Details of Porch, Cornice, Etc., of the George A. Jones Residence

Brought forward	$2.69	$167.21
TWO LOW DOORS—		
2 pairs butts, 2½- × 2½-in. at $.12	0.24	
2 cupboard turns, at $.40	.80	
Labor	1.25	
WINDOWS—		
8 sash fasts, at $.40	3.20	
16 sash lifts, at $.10	1.60	
Labor	5.50	
6 doz. H. & C. hooks, 639½, at $.50	3.00	
3 doz. base knobs, at $.35	1.05	
Labor	3.00	19.64
Total cost of hardware		$186.85

HEATING

FURNACE—		
1 No. 28 Crawford furnace (28-in. firepot)	$138.00	
22 ft. 8-in. galvanized iron smoke pipe, 55 lb. at $.12	6.60	$144.60
REGISTERS—		
1 14 × 18-in. register, stone, box, and netting	$6.52	
4 9 × 12-in. registers, stone, box, and netting, at $2.17	8.68	
4 8 × 10-in. registers, stone, box, and netting, at $1.65	6.60	
4 7 × 10-in. registers, stone, box, and netting, at $1.62	6.48	28.28
PIPING, including dampers, collars, and elbows—		
12 ft. 14-in. tin pipe, at $.29	$ 3.48	
64 ft. 9-in. tin pipe, at $.17	10.88	
278 ft. 7-in. tin pipe, at $.14	38.92	52.28
COVERING FOR RISERS (6 lb. asbestos paper per pipe)—		
5 risers, 30 lb. at $.05		1.50
PLASTERING RINGS IN CELLAR—		
For 13 pipes at $.25 each		3.25
		$230.91
OFFICE EXPENSE AND PROFIT		57.73
Carried forward		$288.64

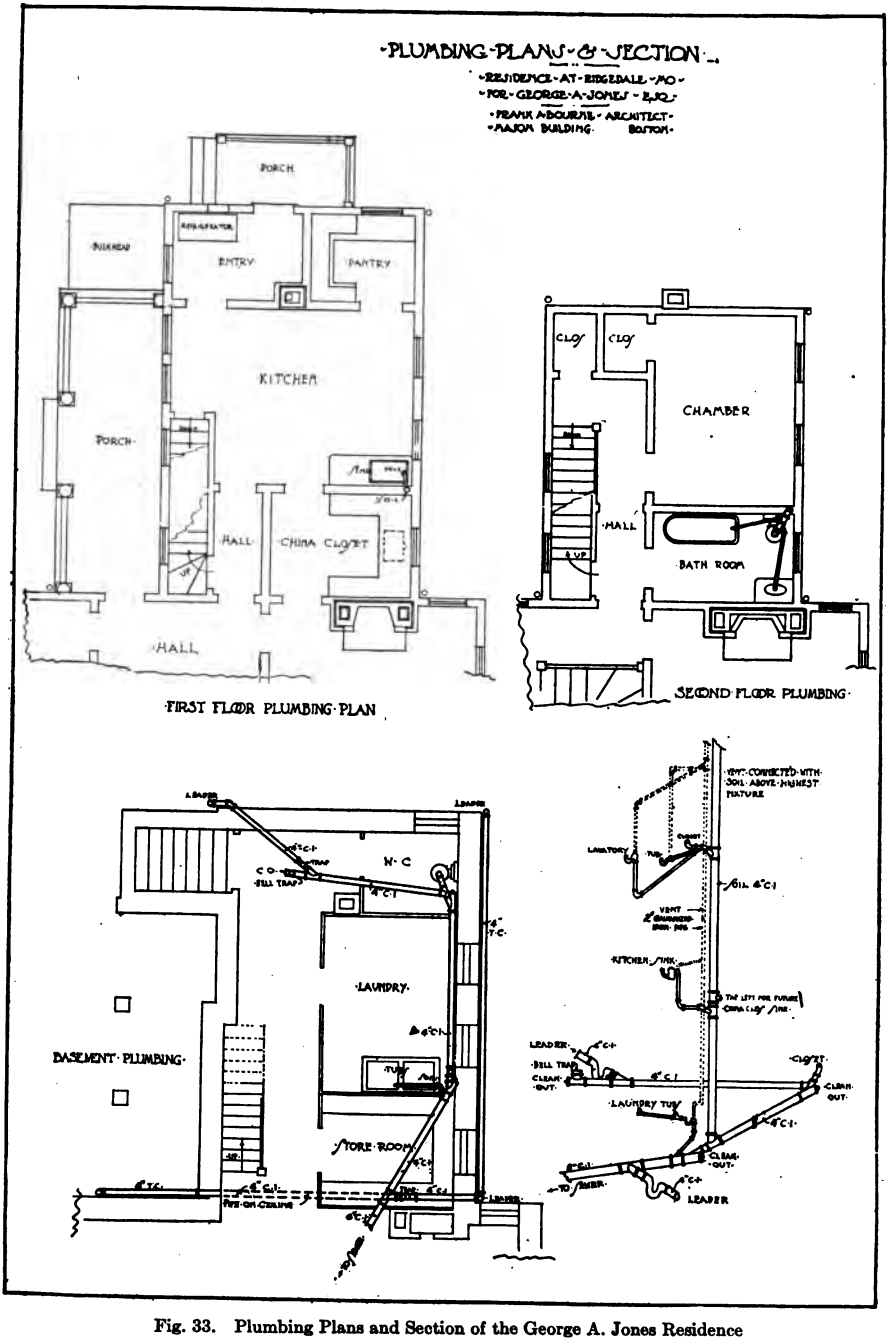


Fig. 33. Plumbing Plans and Section of the George A. Jones Residence

Brought forward		$288.64
LABOR—		
Measuring and laying out risers, man 1 day	$ 5.20	
Erecting risers, man 2 days, helper 1 day	13.20	
Laying out and erecting cellar pipes and furnace, man 3 days, helper 2 days	21.20	
Finishing, man 1 day	5.20	
Carting and expenses	10.00	54.80
Total cost of heating apparatus		$343.44

PLUMBING

WASTE AND SOIL PIPES—		
2 4-in. lead bends, at $3.16	$ 5.75	
2 4-in. sleeves, at $1.00	1.82	
5 2-in. sleeves, at $.54	2.45	
2 3- × 2-in. sleeves, at $.80	1.45	
1 1½-in. Pemberton trap	8.00	
30 lb. solder, wiping, at $.35	9.50	
2 trap plugs, at $.65	1.20	
2 6-in. traps, at $2.14	3.90	
1 6-in. cesspool	2.12	
4 1½-inch solder nipples, at $.40	1.45	
1 4-in. roof flashing	1.82	
Soil pipe	58.00	
15 ft. 1½-in. lead pipe, No. 55	5.88	
50 ft. 2-in. iron pipe 40 ft. 1½-in. iron pipe	10.87	
Soil fittings, ⅓ cost of pipe	19.35	
Cast-iron fittings, ⅕ cost of iron pipe	2.18	$135.74
MISCELLANEOUS FITTINGS—		
3 4-in. brass C. O	$ 2.90	
1 5-in. brass C. O	1.58	
Refrigerator waste	15.15	
Local vents	14.60	
1 ball cock	1.52	
2 sill cocks	3.04	
Tank overflow	7.85	
4¾-in. S. & W. cocks	3.93	
Carried forward	$50.57	$135.74

Brought forward	$50.57	$135.74
1 boiler valve and chain	.76	
25 lb. tinned copper, at $.42½	9.70	
6 3-part hangers, brass	9.44	
2 ¾-in. hose bibs	3.00	
3 ¾-inch plain bibs	4.00	
Street connections	62.50	
1 lb. putty	.06	
2 lb. grafting wax	.65	
Calking lead, 380 lb	32.25	
Oakum	1.95	174.88

FIXTURES—

1 36- × 24- × 8-in. sink, 12-in. back	$14.00	
1 24- × 14-in. pantry sink	17.50	
1 pair pantry cocks	4.40	
2 24- × 48-in. trays, 12-in. back	17.50	
1 5-ft. bathtub, complete	49.70	
1 lavatory, complete	30.00	
1 watercloset, complete	55.00	
1 40-gallon boiler	23.00	
1 40-gallon boiler stand	1.00	
12 lb. fine solder	4.65	
Clamps and hooks	3.30	
Tinned tacks	.15	
Fuel	2.38	222.58

SUPPLIES AND LABOR—

126 ft. ¾-in. galv. water pipe		$ 9.16	
22 ft. ½-in. galv. water pipe		1.25	
Fittings		2.06	
74 ft. ¾-in. brass	$34.40		
56 ft. ½-in. brass	24.30	58.70	
Fittings		9.85	
Painting of iron pipes		10.00	
Stopcocks		4.30	
Sink and tray legs		5.78	
Lead, oil, etc.		.80	
Carried forward		$101.90	$533.20

Brought forward	$101.90	$533.20
Clamping brass and screws	.30	
Cartage and fares	6.00	
Labor, 40 days, at $6.00	340.00	448.20
		$981.40
PROFIT, 10 per cent		98.14
Total cost of plumbing		$1,079.54

ELECTRIC WIRING

NOTE.—The following estimate is figured on outlet boxes at all outlets; and includes a main cabinet and main switch to connect with the meter and to cover the meter, on an 8-circuit panel board, which allows one spare circuit. The panel board is to be made of slate, with slate gutters and linings, with good wooden door and trim.

The labor is estimated on wages of $4.00 per day for a journeyman, and $2.50 per day for helper. This price is above that paid in small places, but is below what is paid in some cities.

SUPPLIES—

25 ft. 1-in. galv. conduit	$ 2.25
1 1-in. pipe cap	.45
1 1-in. elbow fitting	.45
4 1-in. pipe straps	.04
58 ft. No. 6 D. B. R. C. wire	3.48
2 1-in. ground clamps	.24
75 ft. No. 6 S. B. R. C. wire	3.75
30 large knobs	.90
30 3¼-in. No. 14 screws	.24
40 3 × ½-in. porcelain tubes	.60
1 60-ampere double pole fused J. K. switch	.95
2 50-ampere enclosed fuses	.34
Steel cabinet for main switch	2.00
1 60-ampere double pole main line cut-out.	.95
2 35-ampere fuses (enclosed)	.34
1 4-circuit cut-out panel and cabinet	8.00
2500 ft. No. 14 S. B. R. C. wire	21.88
250 ft. $\frac{7}{32}$ flexible conduit (tubing)	3.75
800 5½-in. knobs	6.00
12 lb. 10-penny wire nails	.42
800 leather nail heads	.16
1000 3- × $\frac{5}{16}$-in. porcelain tubes	3.40

200 4-×$\frac{5}{16}$-in. porcelain tubes	$1.00	
100 6-×$\frac{5}{16}$-in. porcelain tubes	1.00	
50 8-×$\frac{5}{16}$-in. porcelain tubes	1.00	
25 10-×$\frac{5}{16}$-in. porcelain tubes	1.00	
48 new work type outlet boxes	2.88	
12 new work type switch boxes	1.56	
1 gross $\frac{3}{4}$-in. No. 8 screws	.15	
$\frac{1}{2}$ lb. friction tape	.23	
$\frac{1}{2}$ lb. splicing compound	.35	
$\frac{1}{2}$ lb. wire solder	.15	
10 S. P. flush push switches	2.70	
2 3-way flush push switches	.70	
12 single switch plates	1.56	
Incidentals	3.00	$77.87
LABOR—		
On rough wiring	65.00	
On mains	18.50	
On finishing	18.50	
Carting	2.00	104.00
OFFICE EXPENSES		36.37
PROFIT		43.65
Total cost of electric wiring		$261.89

ELECTRIC LIGHTING FIXTURES

NOTE.—While the electric lighting fixtures are not generally made a part of the building contract, it may be worth while to consider them in relation to the cost of the house; there is, however, such a wide range in design and cost, as well as in personal preference, that any data given can be at best only approximate.

The following estimate is based upon simple designs of moderate cost in "old brass" finish:

First Story

LIVING ROOM—		
1 4-light electrolier	$27.50	
4 1-light wall brackets, at $6.00	24.00	
HALL—		
2 2-light ceiling pieces, at $3.50	7.00	
VESTIBULE—		
1 3-light cluster	9.00	$67.50
Carried forward		$67.50

Brought forward		$67.50
PORCH—		
1 1-light ceiling-piece	2.50	
PARLOR—		
1 4-light electrolier	27.50	
2 1-light wall brackets	9.00	
DINING-ROOM—		
1 4-light electrolier	20.00	
2 1-light wall brackets	6.00	
CHINA CLOSET, REAR HALL, KITCHEN—		
3 1-light ceiling-pieces, at $1.25	3.75	
2 1-light wall brackets, at $1.75	3.50	139.75
PANTRY—		
1 1-light ceiling-piece	1.00	
ENTRY—		
1 1-light ceiling piece	1.75	
PIAZZA—		
1 1-light ceiling piece	2.50	145.00
Second Story		
HALL—		
2 1-light ceiling-pieces, at $1.75	$ 3.50	
ALCOVE—		
2 1-light ceiling pieces, at $3.00	6.00	
BEDROOMS—		
13 1-light brackets, at $3.00	39.00	
BATHROOM—		
1 1-light ceiling-piece	1.75	
REAR HALL—		
1 1-light bracket	1.75	52.00
Third Story		
HALL—		
1 1-light wall bracket	$1.75	
ATTIC—		
1 3-ft. drop-cord	1.00	2.75
Carried forward		$339.50

Brought forward		$339.50

Basement

LAUNDRY—

1 1-light wall bracket	$1.35	

CELLAR—

4 3-ft. drop-cords, at $1.00	4.00	
		$344.85

Labor

Installing above fixtures with all necessary trimmings	$36.00
Total cost of electric lighting fixtures in place	$380.85

PAINTING

OUTSIDE PAINTING—

17 pairs blinds, 3 coats, at $1.50 pair	$25.50	
1,068 yds. 3 coats, windows and woodwork, at $.25	264.50	
54 yd. 2 coats metallic paint, upper side tin roofs, at $.18	9.72	
62 yd. 2 coats oiling on floors, porch, and piazza, at $.15 yd	9.30	$308.02

INTERIOR PAINTING—

166 yd. filling, staining, and shellacking, and 2 coats hard oil finish, at $.25 yd	$41.50
245 yd. filling and 2 coats spar varnish, first coat rubbed, at $.30 yd	73.50
403 yd. one coat shellac, 3 of paint, 2 coats zinc and white varnish, rubbed with pumice and water, ivory white finish, at $1.00 yd	403.00
294 yd. treated with potash, one oil filler; cleaned; 4 coats shellac, last coat rubbed with pumice and oil, oak and birch, at $.45 yd	132.30
109 yd. filling, 4 coats shellac, last coat rubbed with pumice and oil, floors at $.35 yd	38.15

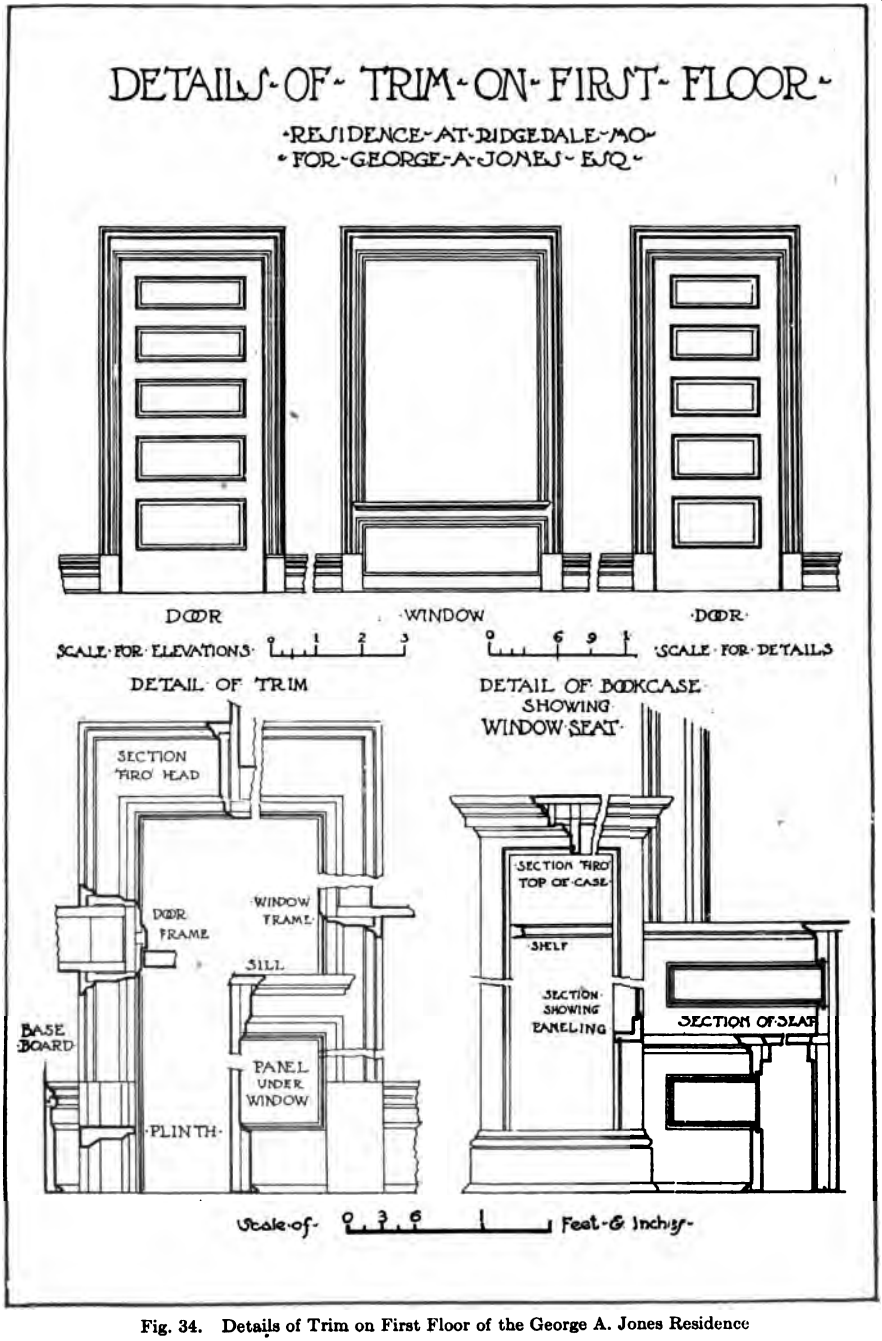


Fig. 34. Details of Trim on First Floor of the George A. Jones Residence

114 yd. size and 3 coats paint, last coat with varnish, walls, at $.25 yd.	$28.85	
5 yd. 3 coats paint and one enamel gloss, bathtub, at $.40	2.00	
100 yd. 3 coats paint, last with zinc, flat, whitewood, at $.30 yd.	30.00	
10 yd. one coat shellac on pipes, at $.10 yd.	1.00	
299 yd. size and tinting in water colors, ceilings, at $.15 yd.	44.85	$795.15
Total cost of painting		$1103.17

GENERAL SUMMARY

Batter boards and water supply	$ 40.00
Excavation	315.00
Stonework, cesspools, and drains	889.74
Chimneys and brickwork	339.16
Concreting	110.25
Plastering	653.28
Carpenter work	5,499.53
Stairs	277.15
Hardware	186.85
Heating	343.44
Plumbing	1,079.54
Electric wiring	261.89
Electric fixtures	241.10
Painting	1,104.17
Total	$11,341.10

ILLUSTRATIVE SCHEDULES

I. ANALYSIS OF CARPENTER WORK

Following is a section devoted to the analysis of the different portions of carpenter work in the foregoing estimate. These show how the prices are obtained, and will be very useful for comparison, as the changes in cost of parts can be noted and kept up to date.

First Floor, price per square of 100 sq. ft., including the floor beams, bridging, and under floors, but no furring for plaster—

Joists, 2- × 10-in., 16-in. on centers	$3.75	
Labor	2.00	
Nails	.15	
Bridging	.50	
Under floor, hemlock, at $27.00	2.70	
Waste, one-third	.41	
Labor	1.00	
Nails	.15	$10.66

Hard Pine Upper Floor, per square of 100 sq. ft.—

Stock	$7.50	
Waste, 15 per cent	2.50	
Labor	3.00	
Nails	.25	13.25

Quartered Oak Upper Floor, per square of 100 sq. ft.—

Stock	$14.50	
Waste	5.00	
Labor	6.50	
Nails	.25	26.25

Porch or Veranda Floor, per square of 100 sq. ft.—

Joists, 2- × 8-in., 16 in. on centers	$2.80	
Labor	1.50	
Hard pine flooring, at $65	6.50	
Waste	2.15	
Labor	1.50	
Nails	.20	14.65

Second Floor, per square of 100 sq. ft.—

Joists, 2- × 10-in., 16 in. on centers	$3.75	
Labor	2.00	
Bridging	.50	
Furring	2.00	
Under-floor stock	2.70	
Waste	.41	
Carried forward	$11.36	

Brought forward	$11.36	
Labor	1.00	
Nails	.15	
Upper-floor stock	5.50	
Waste	1.80	
Labor	2.25	
Nails	.20	$22.26
Third Floor, per square of 100 sq. ft.—		
Joists, 2- × 8-in., 16 in. on centers	$3.08	
Labor	2.00	
Under floor	4.25	
Furring	2.00	
Bridging	.50	11.83
Shingled Roof, per square of 100 sq. ft.—		
Rafters, 2- × 7-in., 20 in. on centers	$2.15	
Labor	2.25	
Matched spruce boarding	3.00	
Waste, one-quarter	.75	
Labor	1.50	
Nails	.20	
Shingles	4.50	
Labor	3.05	
Nails	.25	17.65
Tinned Roof, per square of 100 sq. ft.—		
Rafters, 2- × 7-in., 20 in. on centers	$2.15	
Labor	2.25	
Matched boarding, as above	5.45	
Paper	.50	
Tinning	12.00	22.10
Wall Frame and Boarding, per square of 100 sq. ft.—		
Studding, 2- × 4-in., 16 in. on centers	$5.00	
Boarding	2.70	
Waste	.41	
Labor	1.00	
Nails	.20	9.31
Inside Studding, per square of 100 sq. ft.—		
Stock 2- × 4-in., 16 in. on centers	$1.40	
Waste, one-third	.45	
Labor	2.00	
Carried forward	$3.85	

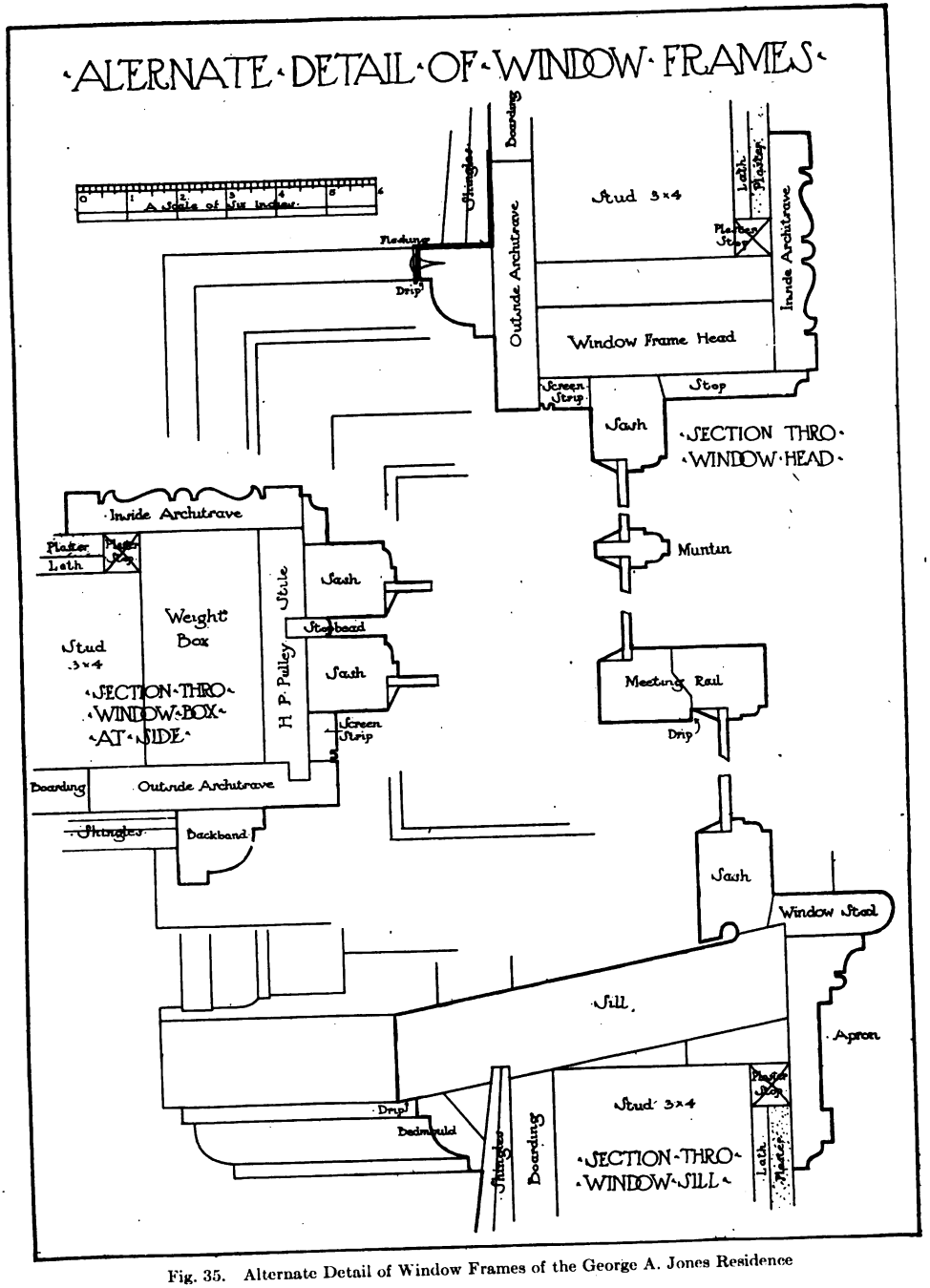


Fig. 35. Alternate Detail of Window Frames of the George A. Jones Residence

Brought forward	$3.85	
Nails	.15	
Grounds and beads	.50	$4.50
Clapboarding, per square of 100 sq. ft.—		
Clapboards, 80, at $0.06½	$5.20	
Labor	4.56	
Paper	.50	
Nails	.20	10.46
Main Cornice, per linear ft.—		
Gutter, per ft	$0.17	
Upper fascia	.03	
Fillet	.01	
Lower fascia	.04	
Planceer	.08	
Bed-mold	.02	
Frieze	.06	
Architrave molding	.04	
Brackets	.25	
Labor	.70	
Rough furring	.10	1.50
Piazza Cornice, per linear ft.—		
Upper fascia	$0.03	
Gutter	.10	
Lower fascia	.03	
Fillet	.01	
Planceer	.08	
Bed-mold	.02	
Brackets	.25	
Frieze	.15	
Architrave mold	.03	
Soffit	.05	
Inside frieze	.10	
Labor	1.00	
Rough furring	.15	2.00
Attic Windows, circular top, each—		
Frame	$6.00	
Sash	2.50	
Inside finish	1.00	
Weights and cord	.45	
Labor	2.25	2.20

Second-Story Windows, 3 ft. 6 in. × 5 ft., each—		
Frame	$1.25	
Sashes, 17½ sq. ft. at $.16	1.90	
Blinds	1.00	
Blind fasts	.15	
Inside finish	1.19	
Nails and screws	.10	
Weights and cord	.74	
Labor, 1 day	4.56	$10.89
First-Story Windows, 2 ft. 6 in. × 4 ft. 6 in., each—		
Frame	$1.25	
Window, 11¼ sq. ft., at $.16	1.60	
Blinds	.75	
Blind fastenings	.15	
Screws and nails	.10	
Weights, 22½ lb., at $.01½	.33	
Cord	.15	
Inside casing, 18 ft., at $.03½	.63	
Backband, 18 ft., at $.03	.54	
Stop beads, 14 ft., at $.02	.28	
Labor	4.56	10.34
French Windows, 4 ft. 6 in. × 7 ft. 6 in., each—		
Frame	$5.00	
Sash, 4 ft. 6 in. × 7 ft. 6 in., 34 sq. ft., at $.20	6.80	
Astragal	.75	
Nails and screws	.10	
Inside finish	.96	
Labor	6.84	20.55
Window, 3 ft. 4 in. × 5 ft. 6 in. (oak finish), each—		
Frame	$1.75	
Window, 18 sq. ft., at $.16	2.88	
Blinds	1.25	
Blind fasts	.15	
Nails and screws	.10	
Weights	.75	
Finish (oak)	2.46	
Labor, 1½ days	6.84	16.18

Rear Door, 2 ft. 10 in. × 7 ft. 6 in.—

Frame	$3.50	
Door, 21 sq. ft., at $.20	4.20	
Finish	.91	
Labor	4.56	
Nails	.05	$13.22

Front Door, 3 ft. 3 in. × 7 ft. 6 in., with top and side lights—

Frame—

Sill, 7 ft., at $.25	$1.75	
Jambs, 23 ft. at $.07	1.61	
Mullions and transom bar, 20 ft. at $.10½	2.10	
Outside casing, 23 ft. at $.03½	.81	
Mullion casing, 20 ft., at $.02	.42	
Labor, one-half price of stock	4.56	11.25

Door, 3 ft., 3 in. × 7 ft. 6 in.—

21 sq. ft., at $.25	$5.25	
Side-light panels, 6 ft. at $.25 per ft.	1.50	
3 sash rims, at $.50	1.50	
Leaded glass, 10⅝ sq. ft. at $2.50	27.00	35.25

Inside Finish—

Stop beads	$0.28	
Architrave, 24 ft., at $.04½ per ft.	1.08	
Labor, 3 days	$13.68	15.04
Total		$61.34

Door, 2 ft. 8 in. × 7 ft. 6 in. (N. C. pine)—

Stock door	$2.35	
Frame	1.25	
Threshold	.15	
Nails	.05	
Finish, 39½ ft. at $.03½	1.38	
Labor	4.56	9.74

Pair Sliding Doors, 6 ft. × 8 ft. (whitewood and birch)—

Doors, 48 sq. ft., at $.50	$24.00	
Architrave, 24 ft. birch	2.16	
Architrave, 24 ft., whitewood	1.08	
Jambs, 22 ft., birch	1.62	
Jambs, 22 ft., whitewood	.85	
Grounds, 22 ft., birch	.50	
Carried forward	$30.21	

Brought forward	$30.21	
Grounds, 22 ft., whitewood	.23	
Chafing strip, 22 ft., birch	.33	
22 ft., whitewood	.15	
Astragal, birch and whitewood	1.50	
Sheathing pockets, 96 ft., at $4.75 per square	4.50	
Labor, 5 days' work	22.80	$59.72

II. SCHEDULE OF HEATING

Memoranda from Which Heating Estimate Is Made Up

First-Floor Rooms	Dimensions of Rooms (ft.)	Contents of Rooms (cu. ft.)	Divide by	Diameter of Pipe Required (in.)	Dimensions of Registers (in.)	Area of Pipes (sq. in.)	Tin Pipe Required Including Elbows (ft.)
Living-Room	14×25×9	3,150	25	2 9	2 9×12	128	34
Hall	11×25×9	3,465	25	14	14×18	154	12
Parlor	12×14×9	1,512	25	9	9×12	64	14
Dining-room	12×14×9	1,512	25	9	9×12	64	16
China closet	7×10×9	....	....	7	7×10	38	24
Second-Floor Rooms							
Bedroom	11×14×8½	1,309	35	7	8×10	38	38
Bedroom	11×14×8½	1,309	35	7	8×10	38	26
Bedroom	11×14×8½	1,309	35	7	8×10	38	40
Bedroom	11×14×8½	1,309	35	7	8×10	38	40
Alcove	6×11×8½	....	....	7	7×10	38	32
Bathroom	6×10×8½	....	....	7	7×10	38	38
Rear bedroom	10×13×8½	1,105	35	7	7×10	38	40

Smoke pipe, 22 feet

Heat-pipe area, 714 square inches

Cold-air box, 534 square inches, or three-quarters of heat-pipe area

Firepot, 28 inches

* Forty per cent must be added to contents of hall for space above.

RESIDENCE OF H. M. STEVENSON, SHERIDAN ROAD, CHICAGO
George W. Maher, Architect, Chicago

CONTRACTS AND SPECIFICATIONS

In order to build intelligently and with profit, it is essential after the scheme has been developed on the drawings—that the materials and their qualities be so selected and so designated that there can be no misunderstanding relative thereto, on the part of either the owner or the builder, and that only such materials be required as the former is prepared to pay for.

INTRODUCTION

THE SPECIFICATION AND ITS FUNCTION

Essential Characteristics. The province of a specification is to supplement the drawings, setting forth those points in the proposed work which cannot be readily expressed by diagram and figures. It may therefore be said that its principal object is to define the general conditions under which the work is to be done, and to describe the quality of the materials to be used. In other words, a specification is a statement of the conditions under which the building is to be constructed, and of the items necessary therefor which are not indicated on the contract drawings.

The specification also presents the general conditions under which the work indicated by the drawings is to be executed. It stipulates the kind and quality of labor and materials desired, and contains all the written instructions and descriptions that may be needed to indicate fully to the bidders just what must be furnished.

Clearness. The completeness and clearness of the specification materially govern the amounts of the bids, and also regulate the amount of extra charges brought in by the contractor at the final settlement; a simple description, therefore, giving as briefly as possible the correct idea to the bidder, is likely to achieve a better result than a long treatise on what is recognized as good workmanship and material by any workman capable of undertaking the contract at all.

Quality and Kind of Materials. As a general rule the specification should give the quality and kind of material to be used, and the method of workmanship, leaving the quantities and sizes to be obtained from the plans. This method, if carefully followed, simplifies the checking-up in completing the plans. Changes in quantities and dimensions can be made on the plans, while changes in material are looked for in the specification.

Notes on Drawings. Specifications are sometimes written in the form of notes on the drawings; but these easily become separated, so that the specification might not be considered for every part of the work on which it would have a bearing. Moreover, as there is not usually room on the drawings for the necessary detail, they never can be as complete as a written description, and at the same time they tend to lead the contractor to neglect the complete specifications. On the other hand, notes on the drawings have a certain advantage in being directly before the contractor. They can be easily and permanently put on when making the drawings, and they show the exact location of the materials mentioned.

General Comments on Wording. *Clear and Exact Language.* Specifications must be written in language perfectly intelligible to all persons connected with the work; special care must be exercised in this, since the specifications, together with the contract drawings, form the basis of the final agreement or bargain between the owner of the proposed building and the builder, this agreement being called the *contract.*

The building to be erected is described by the architect in two ways—namely, by *drawings* and by a *written description,* the specification. The same experience and ability that enable him to make the drawings, will be required in formulating the written statements necessary to express what cannot be fully shown in the design. The importance of the specification is shown in the fact that in case of discrepancy it takes precedence over the drawings.

The diction employed, should, therefore, be carefully considered, so that the specification will be a continuous description of the matter, dealing fully with each subject or each part of the work in proper sequence, and, avoiding all reiteration of requirements either in whole or in part. Short sentences referring first to one

subject and then to another, and of doubtful connection, should never be allowed.

Terms Used in Grading Material. Words should be used in their most common meaning, and if an expression indicates only a trade term for a locality, it should be so stated. "First quality" as a trade term, for example, may not mean the best in the market; "Extra No. 1" shingles are not so good as "Extra"; "6-cut" stonework may show many stones which would not appear if "Good 6-cut" were called for. If the architect is not fully informed on these points, he should study more carefully the grades of materials being put into buildings, and how they appear in structures that have stood for some time. Visits to supply houses, mills, shops, and stoneyards, will repay the time spent.

Such expressions as "best", "proper", "sufficient", etc., are capable of being interpreted in very different ways, according to the point of view of a good or a poor workman.

Accuracy of Statement. Generally speaking, adjectives and adverbs and all general description should be dispensed with. The requirement that work shall be finished "in the best possible manner" means very little. A reasonable interpretation of "best work" for a house costing $1,500, would be entirely unsuitable for a house costing $15,000; and as all through the scale the meaning varies, it will be evident that the contractor, influenced by his intent to make a profit, and the owner, influenced by his desire to get his money's worth, will have widely separated views as to what the "best" is. The architect, in attempting to decide the question, is likely to get the ill-will of both.

Each requirement should be so carefully written that there can be only one interpretation, with absolutely no doubt as to its true intent. If the specifier hopes to get better work through some hidden meaning in the specification, he is doomed to disappointment; for the more expensive interpretation will be used by the contractor in making his bid, but later, when the work is required, he may plead that, on account of the uncertainty of meaning, he should not be required to do the work the more expensive way without extra compensation. Make the specification fair and honest, for it is the basis on which the architect will stand as arbitrator during the progress of the work.

It should be remembered that it is the province of the workmen to comprehend and not to originate; and so the statement of what is to be constructed should be made very clear, leaving nothing to the imagination of the contractor. A statement in the specification of what could be better shown on the drawings is likely to be poorly comprehended by the builders; on the other hand, the owner of the building will be wont to think more of the specification, since he can understand this more clearly than he can the drawings. There should be nothing, however, in the specification, or in any part of the work, to discourage originality, personal interest, and the exercise of judgment on the part of the workmen.

Province of Specification. Before a specification is begun, its limits are fixed by the drawings; on them the scheme is illustrated fully, the material indicated in a general way, and all sizes shown. Two tasks are the imperative duty of the specification writer:

(1) To acquaint himself most carefully with all that is illustrated by the drawings;

(2) To determine all that is not given in the drawings.

Having settled in his mind the second point, he has the province and the limits of his work before him; for, as above stated, it is the province of the specification to set forth those points which cannot be explained by the drawings. A most careful study of the drawings, therefore, is necessary, in order to learn every point in the proposed scheme which they do *not* cover—points which *must* be covered in the specification.

To attempt to emphasize requirements already fully shown in the drawings, by calling attention to them again in the specification, adds nothing in the way of obligation, and has the effect of casting doubt on those requirements which are not thus doubly set forth.

A careful consideration, then, of the province of the specification will show that its functions are to define the relations between the different parties, the conditions under which the work is to be done, and the materials used in execution. These are the points which have everything to do with the cost of the work. In building, as in most other items, the form and shape have less to do with the cost than have the conditions under which the work is done and the materials required therefor.

As Relates to Contractor. Specifications should never impose conditions which can involve the contractor in any unnecessary trouble or expense. They should aim so to modify all conditions that the contractor will feel others are co-operating with him to produce the desired result without unnecessary expense or inconvenience. The result desired should always be made perfectly clear and apparent in the wording of the specifications; the means of obtaining that result should, except in rare cases, be left to the judgment of the contractor, who alone is responsible for such result.

Sometimes it is imagined that, unless the conditions are set forth with some degree of harshness, the owner will feel that sufficient protection to his interests has not been provided; but, before the completion of the work, he will probably realize, from the smoothness with which the work progresses, that the tact of his architect has saved him much annoyance and a considerable sum of money.

As Relates to Architect. The writer of the specification must clearly bear in mind, throughout his entire work, that the architect is to occupy a unique position in carrying out the work—a position which in almost no other line is occupied by one individual. The architect is the confidential professional adviser of his patron; and also, as the work progresses, he is to be the unbiased arbitrator, often between opposing interests, one of which is that of his patron or employer. The office of arbitrator is difficult, and one which it is generally impossible to occupy at all times to the satisfaction of both parties; and as the unconscious influence of the patron's interests is very likely to warp the judgment of the architect in making interpretations which must govern, it is very necessary that in the specification all matters be stated so clearly that differences of interpretation will seldom occur, and that when they do occur the specification will give the architect ample standing room, so that his judgment may be accepted without either party feeling wronged.

"Standard specifications", which require "standard materials", put in by "standard methods", have done their part most fully to discourage owners, contractors, and, finally, architects. The same judgment used in buying supplies of life that will satisfy require-

ments, should be used in buying building material; and success in buying depends on knowing how to buy.

Parties Concerned. *Owner.* The owner is the autocrat; his wishes are to govern, and unless his interest can be thoroughly aroused, the transaction will probably end unsatisfactorily. There is no person so hard to serve as one who, while feeling it necessary to build, has no interest in the process. The work, when done, will never be quite what he thought it would be, and he will never be satisfied. The interest of the owner should, therefore, be enlisted concerning as many details of materials as possible, and the reason for using one and not another. His questions will at first be trying. Possibly the first query will be: What will be the increase in cost of a brick or stone-faced house over a wood house?—and no amount of argument or explanation will convince him that no definite ratio exists. But the question can be used as an excuse to discuss the different qualities of brick, or the kinds of stone which he prefers, and soon technical knowledge of these materials will awaken an interest and call out more rational questions. This discussion will reveal the kinds of materials which will be satisfactory to the owner and an estimate quickly made by the architect will answer the question.

It is the right of the owner to understand all the differences in quality of materials, and why each kind is to be used. If he does not, he will probably be much annoyed by the wiseacres, who are sure to criticise everything delivered on the site, and the end will probably be severe criticism of the architect, who "did not know enough to specify the best." It will rarely occur to the owner, that, had the "best" been specified, it would have carried his building well into the hands of the mortgagee. The owner's interest if once aroused, will lead to a co-operation with the architect and the contractor, which will encourage the owner to "give and take" in minor matters, to the mutual advantage of himself and the contractor.

It is, further, the owner's right to have freaks and notions; and, after a careful presentation of the case, his ideas as to materials, though they may be decidedly different from those of his architect, should be respected, and the material incorporated as dictated by him. Herein is the opportunity for the architect to use his best

technical knowledge, and so to meet the conditions that in spite of them the result will be satisfactory. The architect who says that he carried out the dictations of the owner and is not responsible for the result, is likely to lose a patron and possibly to make an enemy.

Contractor. As a general thing, the only object the contractor has in mind in taking the work is the pecuniary profit to himself in the transaction. It is rarely that satisfactory results can be obtained from a man who is losing money; generally he so manages that the owner is as great a loser, and the architect is blamed for the losses of both.

While the contractor is under obligations, after taking the contract, to carry out the work "as directed", it is well to remember that his assumption of the contract was a purely voluntary act, and that he was under no obligation to take it. It is his right to know, before he puts in his bid, just what he is expected to furnish and to do, not to be left to furnish what, in the judgment of someone not interested in him, are materials of "best quality" or "good quality." Nothing will so much tend to draw from the contractor the best results, as to sense a feeling of co-operation on the part of both the owner and the architect.

Specification Writer. The central figure in this transaction is the specification writer. His tact must arrange the conditions under which the work is to be done; his technical knowledge must supply the data, and set forth in clear, explicit language, the description of the material which the contractor is to furnish and the owner is to accept. He is to be the arbitrator when any question arises affecting the interests of both in conflicting ways, and for his own comfort the arbitration must be such that both sides will see its full justice. In order that the necessity for arbitration shall present itself as seldom as possible, it is essential that all the conditions and questions liable to cause misunderstanding be fully studied and settled in the specification. It is the duty of the superintendent to see that the contractor follows out the requirements of the specification, but it is unfortunate to have the specification so loosely written that the requirements are ambiguous, or at least not explicit, and the contractor is made to feel that he is distrusted, or that he is obliged to furnish materials or labor at a loss under an arbitrary

decision, which, had the detail of the specification been more clearly given he would have avoided.

Particular attention is called to the following paragraph, as the advice contained therein is of the utmost value:

The specification writer must be a man of tact and technical knowledge. It is outside the scope of this paper to discuss the former quality, except in a most general way, but an effort will be made so to treat the technical side that the student can develop lines of thought that will enable him, whenever questions arise, to attack them from such points as will gain for him the necessary inside information; in no sense is it the intent of this paper to set up such matter as will serve as models and forms to be applied to miscellaneous conditions. The training of the specification writer should be such as to accustom him to think in building material; *and when the habit is formed, the student, in passing from day to day, structures completed or in course of construction, will constantly find himself reasoning as to the use of various materials. This is technical education. No school, no matter how long or how thorough its course, will cover all the points to be decided in the first modern specification. All the training any school can give is to teach a man to think out the solution of his first and each succeeding commission along sound lines. This is the character of work which rouses enthusiasm in the worker and without which the work will amount to little.*

POINTS OF EMPHASIS IN SPECIFICATION WRITING

Preliminary Work. It is advisable for the specification writer to block out a *memorandum specification,* indicating very generally the points which will be completely covered in the finished copy, and to do this at the time the architect is making the preliminary sketches, which indicate the scheme to be followed later in the contract drawings. With this preliminary specification a close estimate of cost can be made, and the modifications incorporated which are necessary to bring the cost of the work within the stipulated sum. In the final writing, however, this memorandum should be used only for reference, as an effort to copy any part of it bodily into the completed work is likely to introduce matter not desired, or to cause the omission of essential matter not considered at the time the memorandum was made.

There are certain data that it is advisable to obtain before writing

the specification, such as the information obtained from test borings to determine the condition of the soil, references as to the location of sewers and water-supply pipes, etc.

Bill of Quantities. It is sometimes held that the specifications should be considered as a sort of index of all the labor and materials required in the structure, and that any items not mentioned in this index cannot be required. This feature, however, is the province of the bill of quantities which in this country is prepared by the contractor for his own use, and not by the architect. The contractor makes up the bill of quantities from the drawings and specifications which together show the shape, size, and quality of materials, but which should never attempt to state the quantity in detail; for if an attempt is made to designate where materials are to go, and if for any reason every single point is not covered in such designation in the specifications, the contractor may seize upon the omission as an excuse for an "extra." There is a growing sentiment, however, in favor of the employment of a *quantity surveyor,* whose duty it is to make up from the architect's drawings and specifications a bill of quantities, to be used by the competing bidders, and to be later the basis of the contract or agreement between the successful bidder and the owner.

Form of Publication of Specifications. Specifications are ordinarily typewritten, and several copies are usually made—one copy for the owner, from one to three for the contractor, one office copy, and extra copies which may be used in securing estimates, supplied to the Inspection of Buildings' Department, etc. If many copies are required, the specifications are sometimes lithographed, printed, or mimeographed. It is the custom in some offices to print in typewritten form, or to mimeograph, the general conditions only, which are the same in different specifications; but it is better to have the general conditions written in the same form as the general specifications, for if they are not the contractors are likely to overlook them and to neglect the directions therein stated.

Marginal Sketches. Sometimes sketches are made in the margin of the specification to indicate the use of materials or to show required details. This can be done easily if the specifications are printed or lithographed, but under the present system of duplicating by typewriting, it is difficult. This sort of information can

be shown more completely on the regular drawings, which can be reproduced in sufficient quantities to explain every item.

Preliminary Estimates. Preliminary estimates are generally obtained from some "reliable contractor," who is called in before the specification is complete, to estimate the relative cost of certain parts of the building where there is doubt as to which of two methods or materials to use.

It is better, however, for the architect to become familiar with the prices of different items, so that he can estimate for himself the cost of various schemes, unless the owner has settled on one particular contractor to whom the work is to be let. When the "reliable contractor" is called in, he appreciates fully that the time he puts on the estimate will be in the nature of gratuitous services, or nearly so, and therefore careful figures are not made, and often the architect and owner are both misled.

Classification of Work of Different Trades. The opening description of the work should be straightforward, clear, and concise. The specification should be carefully classified according to the different trades, so that each sub-contractor and the estimator of every small shop may find the work he is to do definitely indicated. It is easy for a general contractor to unite sub-contracts and let several to one firm, but very difficult to subdivide a specification where trades are not differentiated. This should not lead the architect, however, to separate work among different trades, if safety, warranty, or promptness requires that certain parts of the work shall all be under the control of one contractor, as, for example, the roofer.

Each item describes the class of material to be used and the kind of labor to be employed. The number of pieces and the dimensions are left to the plans; though when, however, the plans are incomplete on account of the small scale, the quantities and sizes must be given fully and completely in the specifications.

The usual method of arranging a specification is to classify the items under each building trade, and then to subdivide the building trades as much as possible. Commence with the work to be done on the foundation of the building and carry the description up through the building to the roof in the order of construction. In this way there is less danger of omissions. Sometimes it is advisable to de-

scribe a certain part entirely under the trade that would have general charge of it. For example, an iron staircase would be described under "Iron Work," and the description would include a wooden handrail. Metal flashings, it is often specified, are to be furnished by the carpenter, mason, or plumber for use in connection with their work, though frequently these are provided by the metal worker and set by the carpenter, mason, or plumber.

It should be stated and understood that every contractor is to report any defect or discrepancy, as soon as observed, to the architect, and to lend his personal interest and attention to the best possible execution of the whole work.

Alterations in Specifications. The sets of specifications as well as the drawings which they accompany, must be kept unchanged, for reference, both when the estimates are received and when the contract is signed. Later changes must be shown by other drawings and by "addenda" to the original specifications. Interlineations in a specification should not be made if there is time for rewriting. If made at the last moment, they should be signed individually at the time of signing the contract. All changes introduced after the specification is completed and the contract let, which involve extra charges, should have each a complete descriptive specification written, referring to the general specification.

Arrangement for Reference. In writing out the specification, it is advisable and usual on public work to number every clause under the different trades in order. These numbers will be found very useful for reference and comparison during the work. An index may be placed at the beginning of the specification.

Inclusion of Indirect Items. There are many indirect items which should be fully covered by the specifications—for example, the requirement that the contractor shall take care of certain minor points, such as clearing out rubbish, covering the windows, and heating the building while the plaster is drying, putting up staging, etc. Even when there is a general contractor for a building—which would relieve both architect and owner of any direct responsibility —it saves much discussion between the sub-contractors if such points as these are included in the specification.

Attention to Public Regulations. Due consideration must also be given to the various state and municipal regulations which are

enforced for the preservation of public health and safety; and also to insurance regulations which apply primarily to the prevention of property loss by disaster of any kind.

These regulations are directed principally toward securing sufficient strength and stability to prevent collapse of construction, sufficient protection against fire from within or without, adequate ventilation and sanitation, and have regard, besides, for measures of public welfare such as open areas, the protection of property values, and the improvement of civic beauty.

Where there are definitely stated requirements in state or municipal building laws, use the same wording or expressions in the specification. The provisions in the laws are the result of long study and practical experience, and often the difference of a single word will confuse or obscure the meaning to the contractors. The specifications may be abbreviated by referring directly to the building laws, and omitting what is there clearly stated.

Restriction on Architect's Powers. While every specification should require that the work as a whole and in all details shall be carried out to the satisfaction of the architect, such requirement must carry with it the full understanding that the architect shall be satisfied when the contractor has furnished what the clear meaning of the drawings and specification calls for, and under no circumstances shall the architect, under the excuse that what has been furnished is not satisfactory to him, demand other than that which is required by the drawings and specifications.

Use of Warranty Clauses. It is often desirable to stipulate that certain portions of the work are warranted to exercise their functions properly when completed, and for a certain period of time thereafter. For example, the heating specification may stipulate that the apparatus is to maintain a temperature of 70 degrees when that of the outside is at zero or 30 degrees below; or it may be that the roof is to be warranted to remain waterproof for a certain length of time. Such warranty clauses should be sparingly used, for in case of a defect in the portion warranted, it is generally as expensive to get the person who installed the defective portion to remedy it, as to get the work done over by another party, and the delays incident are annoying in the extreme. When a warranty clause is used, it is generally made an excuse for constantly chang-

ing the work from that specified, under the plea that, if carried out in accord with the contract, the work cannot be warranted. Such changes are always in favor of poorer work. It is generally better for the architect to know just what materials will do the work, to see that such are installed, and to leave the warranty clause out.

Specification for Particular Brands. Specifying a particular make or brand of material is likely to carry the impression that the writer's knowledge is limited or that he is unduly influenced in favor of the article specified. If a particular appliance is required, it is well to except it from the contract, and say that the owner "will furnish, ———————— delivered on the site, which the contractor is to set in place and connect," etc.

Employment of Consulting Experts. In important work, specifications on electric wiring, heating, plumbing, ventilation, etc., are frequently prepared by consulting engineers employed by the owner to arrange these points under the direction of the architect. In this case the engineers prepare the specifications, which can be included in the architect's other specifications, and any questions that may come up during the progress of the work should be referred to the consulting engineer by the architect before a change is made. The employment of consulting experts is common in the erection of high buildings, where engineers are frequently engaged to lay out the steel construction.

But when the services of specialists in any line are required, it should in all cases be understood that the general scheme for the work is not to be altered, and that the engineer is to adapt his portion of the work to the general plan, and not to insist on modifying the general plan to suit any particular methods or appliances he may desire to use.

Specification as to Payment and Time of Completion. In a building operation, four questions always arise:

(1) What is to be done?
(2) How is it to be done?
(3) When is it to be completed?
(4) What is to be the manner of payment?

The first two questions are answered by the plans and specifications. Although the last two are finally stated in the contract, it

is necessary that some reference should be made to them in the specification, for the information of the bidders.

The period for completion may be stated in terms of months and days after the signing of the contract.

Payments on the contract may be made by one of four methods:

(1) Stated sum
(2) Cost plus a percentage
(3) Cost plus a percentage with guaranteed limit
(4) Cost plus a fixed sum

The first is the usual way in contracting work.

Full information relative to the method of payment which the owner prefers and intends to incorporate in the contract, should be set forth in the specification, as this is a matter which will have a marked influence on bidders.

If "payment by stated sum" is agreed upon, then, unless the payments can be arranged so that the owner supplies money for the material and labor at frequent intervals, it follows that the contractor has to use considerable of his own capital or credit to carry the work along. For this he must be paid; and, therefore, as the owner generally has the funds prior to beginning work, it is advisable to state in the specification such dates and percentage of payments as will permit the contractor to carry on the work with a minimum charge for the use of his own capital or credit.

SPECIFICATION WRITER'S METHODS OF WORK

Outlining Main Divisions of Work. The completeness and clearness—and therefore the usefulness—of a specification, depend on its systematic arrangement. The first thing to do, therefore, is to prepare a skeleton or outline of what is later to be the finished form. This should consist, in the first place, of a list of the different *general* branches of the work. Then, under each of these general heads should be set a list of sub-heads; but it is not good policy to attempt to cover every point before beginning the writing of the specification proper, as, in writing, items will constantly occur to the writer in connection with what has already been written. After this skeleton has been prepared, the major part of the work is done, as the filling-in and detailing of requirements under each heading is a comparatively simple operation.

Use of Card Catalogues. On smaller work, where the Architect is both designer and specification writer, the job will be, or should be, so in mind that no assistance is required in arranging this skeleton; but in larger offices, where generally the first time the writer sees the drawings is when he begins consideration of the specifications, it is very desirable—in fact necessary—for him to have some reminder of the items which are to be considered. These reminders may be in the form of the catalogue cards which are used in some large offices to list specification items. Each card contains notes and memoranda relative to one item, and the cards of the file can be easily grouped and re-grouped—using markers or wire clips—to take care of the particular requirements of each contract. With these in hand, the specification writer, although hitherto unacquainted with the drawings, can work intelligently and effectively. As the use of the cards extends, the information accumulated on them becomes very valuable. Items observed from day to day in technical papers or on buildings in course of construction, and facts gleaned from conversation, should be noted on the cards in careful but abbreviated fashion, under the proper headings, and these will recall the details of the case when their assistance will be useful.

Analysis of Task. The drawings, after they have been delivered to the specification writer, should be most carefully studied, for the whole scheme of design, arrangement, use, construction, and decoration must be well in mind. Having obtained a broad, comprehensive impression of the work, the general method of obtaining the results desired, is next to be studied. Considerable time can be spent in this work to advantage. It is a good plan, after what has seemed a sufficient period of study, to sit down, close the eyes, and call to mind the different parts as a whole and in detail. If the scheme then appears clear, and can be followed out understandingly in the mind, without reference to the drawings, then—*and not until then*—is the writer fitted to begin the work. With such preparation he can with surprising rapidity lay out his first line of main heads, and with a similar rapidity, his subheads; when these are completed, the main part of the work is done. Too much stress cannot be laid on the importance of a clear comprehension of the entire scheme, as a whole and in detail, before a word is written.

If the writer fails in this, his specification will be neither clear nor complete, and will be likely to degenerate into a series of disconnected sentences with little or no affinity for those which precede or follow.

Specification Reminder. There is given below a list of headings which cover certain items generally needed, with occasional notes written out to illustrate how other notes can be made when experience furnishes the material. It is especially desirable to call attention in the notes to any particular difficulties in any line of work which may have been previously observed, and the means employed to correct them.

GENERAL CONDITIONS

Division of work
Work to be done
Quality
Materials and labor
Delivery of materials
Contractor
Laying out of work
Engineer
Permits
Building laws
Fences
Office
Vouchers
Inspection
Protection of work
Rubbish
Scaffolding
Defects
Assistance to other contractors
Cutting
Architect
Drawings and specifications
Detail drawings
Charges
Bond
Insurance
Ownership of old material
Water supply
Temporary watercloset
Contingent work
Award
Terms of payment
Changes
Time for completion

MASONRY

Alterations and Shoring

Shoring
Raising
New openings
Piers
New underpinning

Demolition and Removal

Old building
Tearing down
Removing walls
Brick
Old vaults and cisterns
House mover
Ownership of old material
Removal of old material

Excavating and Grading

Location

(If there is much change of level it is advisable to have a surveyor lay out the finished grades.)

Clearing the site
Excavation for cellar
Excavation for areas
Excavation for drains
Excavation for water
Excavation for cesspools
Blasting
Grading

(If possible, have the scheme of grading laid out before beginning to build, in order that the earth excavated from the cellar may, with one handling, be carried to the proper location to carry out the scheme.)

Footings below frost
Shoring
Bracing
Temporary piling
Surplus earth
Saving loam
Trees
Shrubs

Stone Masonry

Lime—Cement—Sand
Non-staining cement
Mortar—Ties
Facing walls
Bed of stone
Bond of stone

Damp-proofing
Coping
Curbing
Concrete floors
Steps
Walks

Cut Stone

Stock—Limestone; sandstone; granite
Finish

Carving
Cleaning

Concrete Construction

Cement—Sand—Aggregate
Mixing

Reinforcing materials
Blocks—Beams—Forms

Brick Laying

Common brick—Sand mold—Pressed; enameled
Lime—Cement—Sand
Bond—Common; English; Flemish
Cutting
Wetting brick
Freezing weather
Bedding window frames
Chimneys—Flue linings

Chimney caps
Chimney bars
Chases
Hollow walls
Boiler setting
Register openings
Rough fireplace openings
Iron doors

Terra Cotta

Partitions
Floors
Furring

Fireproofing
Ornamental terra cotta

Plastering

Grounds
Wood lath
Metal lath
Back plaster
Two-coat work
Three-coat work
Exterior plaster
Pebble dash
Lime and sand mortar
Hair
Patent plaster
Corner beads
Cornices
Relief work

Tile Work—Marble and Slate

Fireplaces
Interior marble work
Mosaic
Terrazzo
Bathroom
Walls—Floors
Plumbing marble

STRUCTURAL STEEL AND IRON

Quality—Cast; wrought
Tests
Bolts
Rivets

ORNAMENTAL IRON AND BRONZE

Cast
Forged
Grilles
Elevator enclosures
Steps
Coal-hole cover
Stable fittings

MISCELLANEOUS IRON

Fire escape
Balconies
Wire guards
Tree guards
Wheel guards

SHEET-METAL WORK

Copper
Lead
Zinc
Gutters
Ventilators
Flashings
Skylights
Cornice work
Eave troughs
Speaking tubes
Ventilation flues
Heat ducts

ROOF

Tar and gravel
Copper
Canvas
Tin
Shingles
Slate
Valley
Flashings
Snow guards

CARPENTER WORK

Framing
Sheathing
Lining
Flooring
Window weights and cord
Exterior finish
Cornice
Closets

Finish lumber
Paper
Doors
Sash
Blinds
Glass
Interior finish—Pine; hardwood; natural; paint
Refrigerators
Mantels
Stairs

HARDWARE

Locks
Knobs
Escutcheons
Sash locks
Sash lifts
Springs
Hooks
Knocker
Hinges
Special hardware for casement windows
House number
Blind fixtures
Screen

PAINTING

Lead
Oil
Shellac
Varnish
Colors
Putty
Whitewash
Number of coats for each material
Finish
Exterior stains
Metal work
Roof
Interior walls
Plumbing pipes

GLASS

Plate—Double-thick; single-thick
Stained—Ribbed; wire
Cleaning
Glazing

HEATING

Laying out work
Cutting, etc.
Foundation
Flue
Furnace
Cold- and hot-air ducts
Registers
Boiler
Piping and hangers
Valves
Heat regulator
Radiators
Tank
Boiler and pipe covering

PLUMBING

Fixtures
Bowls
Closets
Bathtubs
Wash-trays
Sinks
Urinals
Connection with waste pipes
Laundry stove
Hot-water boiler
Water front
Water piping
Shut-off cocks
Soil piping
Branches
Traps
Refrigerator waste
Back-air pipes
Fresh-air inlet

GAS

Pipes	Stove connection
Tests	Gas machine
Outlets	Gas logs

ELECTRIC WORK

General description of scheme	Fixtures
Wire	Switchboard
Conduits	Switches
Outlets	Meter connections

The list given is not intended to be in any sense so complete as to be a sufficient guide to work in *all* buildings. It is inserted to illustrate the scheme often used in offices where the specification writer is somewhat unfamiliar with the work already laid out on the drawings. Practice differs so radically, and the range of building is so wide, that a comprehensive list, covering all the multiplicity of questions that arise in connection with buildings, would be cumbersome. But, following the lines above laid out, each specification writer can rapidly accumulate what he needs in his particular line; and the *operation of seeking* for new items of importance in practice will be a source from which much valuable information and experience will be obtained.

Practice for the Student. Before proceeding, the student should prepare a schedule along the lines suggested above, but specifying under each heading at least double the number of subitems mentioned.

He should also write a description of the character of work referred to by each heading, these descriptions each to contain approximately one hundred words. Below is given a brief description of the subject of "Heating," which will serve to illustrate the work the student should do:

HEATING

There are five principal methods of heating dwellings—namely, by fireplaces, by stoves, by furnaces, by steam boiler, and by hot-water boiler—all adapted to fuels in common use.

Fireplaces are suitable in mild climates, and to supplement more efficient apparatus in cold climates.

Stoves are the most economical, but are often objectionable fixtures.

Furnaces deliver heated air to the various rooms, and are satisfactory for small buildings.

Steam and hot water supply heat from radiators in each room. Steam responds more readily than hot water to variations in the size of the furnace fire, and should be used, therefore, when quick changes in temperature are desired. It should also be installed in the larger classes of buildings where it can be easily controlled.

Hot water should be used when an even temperature at all times is desired.

Use of Similar Specifications as Basis for Work. New problems are constantly arising which tax the ingenuity of even the experienced architect, and which necessitates new directions. Many building operations have requirements so unusual that any aid except that of general experience will be of little value. As a rule, however, good results will be achieved if the specification writer uses the written or printed specifications prepared previously for work of similar character, or the cards which record the separate items, and makes thereon the necessary changes, giving meanwhile careful and constant attention to the plans, and comparing frequently the plans and specifications. Before the drawings are sent out, the specifications should be carefully checked with the "specification reminder," to discover omissions. In work containing unusual or elaborate detail or intricate alterations, it will be easier to write out a new specification completely than to alter an existing one.

Final Steps in Preparation of Specification. The specification writer generally starts his work with the drawing hung on a wall or screen near by. With the plans closely in mind, he should block out the list of headings, forming a skeleton or general synopsis of the whole. Then he should go through the different trades, checking, writing, and dictating, either following a card catalogue, taking a printed form or standard specification and filling in the blanks, or using an old specification and interlining the changes, which are then copied to form the complete document. Extra care must be taken to cover new and important points that are likely to be insufficiently studied. It will be found rather difficult to make an old form apply to a new building, without the use of too many general terms and "blanket clauses."

Having made a thorough study of the subject, the specification writer may lay out his work under the following headings:

I. GENERAL CONDITIONS
II. EXCAVATING AND GRADING
III. STONEWORK
IV. BRICKWORK
V. LATHING AND PLASTERING
VI. METAL WORK
VII. CARPENTRY
- Framing
- Exterior Finish
- Interior Finish
- Hardware

VIII. PAINTING
IX. GLAZING
X. HEATING
XI. PLUMBING
XII. GASFITTING
XIII. ELECTRIC WIRING

Under each general heading will come many and various subheads. Thus, for instance, under "GENERAL CONDITIONS," will be listed such items as "Material and Labor," "The Contractor," "The Architect," "Drawings and Specifications," "Details," "Time for Completion," etc.; under "EXCAVATION," "Preparation of Site," etc. Every aspect of the work should be included in the complete outline.

SPECIFICATIONS FOR SUBURBAN WORK

The following specification is given to show the method of writing a specification for a particular building. In every case the architect should consider every item necessary for the building and should write out exactly what is desired.

SPECIFICATIONS

FOR A COUNTRY HOUSE TO BE ERECTED FOR

GEORGE A. JONES, ESQ.

AT RIDGEDALE, MISSOURI

Frank A. Bourne, Architect

GENERAL CONDITIONS

Materials and Labor. All materials and labor required for the complete execution of the work are to be of the best quality, unless otherwise provided, and are to be furnished in place by the Contractor. The Contractor is also to furnish all scaffolding, apparatus, etc.

Contractor. Personal superintendence is to be given by the Contractor to the work, and a competent foreman is to be at all times on the work. He is to lay out the work carefully, and shall be held responsible for any mistakes which he, or any one in his employ, or any of his subcontractors, may make.

He is to be responsible, also, for any accidents either to person or property, which may occur in connection with the execution of the work either directly or indirectly, for which otherwise the Owner might suffer.

He is to obtain all permits from the city officials required by ordinances; is to pay all fees for water supply, sewer connections, etc.; and is to follow all the requirements of the building laws, whether incorporated in this specification or not.

He is to be responsible for all materials, whether incorporated in the building or not, until the final acceptance of the work; and any damage there may be from any cause is to be repaired; or, if beyond repair, the damaged portion is to be replaced.

He is to keep the building fully insured; and all policies are to be so drawn that the loss, if any, is to be paid to the Owner as his interest may appear.

He is to provide such fences as may be required to protect adjoining property.

Architect. The Architect shall have charge of the work, and is to exercise such supervision as will enable him to determine whether the true spirit and intent of the drawings and specification is being carried out. If, in the exercise of this function, he finds that any employe of the Contractor is, through incompetence or wilfulness, a detriment to the work, he shall file with the Contractor definite charges; and, upon the filing of such charges, the Contractor shall discontinue the services of such employe in connection with this work.

The Architect shall issue on the third of each month a voucher calling for ninety (90) per cent of the value of labor and material incorporated completely in place in the building on the first of the month, which voucher shall be honored on presentation to the Owner; but this clause will not require the Architect to include in the voucher the value of any material placed in the building which in his opinion does not meet the contract requirements.

The Architect shall be the interpreter of the intent and meaning of the drawings and specification, and his decision shall be final and binding on both Owner and Contractor.

Drawings and Specification. The drawings and specification are to be considered as co-operative; and the material or work called for by one and not indicated or mentioned in the other, is to be furnished and done as though fully treated in both.

If no figures or memoranda are given, drawings are to be accurately followed according to scale; but wherever there are figures or memoranda, these are to be followed instead of the scale, if there is a discrepancy.

Detail drawings shall be furnished of such portions of the work as the Architect may desire to explain more fully; and any work constructed without such drawings (except by permission expressly obtained), or not in accordance with them, must be taken down and replaced at the Contractor's expense.

No changes are to be made without a written order signed by the Architect; and the adjustment, whether allowance or extra expense, is to be made at that time.

Time for Completion. Work is to commence at once, and is to proceed with promptness and despatch.

Work is to be completed and building delivered to Owner six months after date of contract. Times of completion of the different parts are to be as follows, the time allowed in each case to be from date of signing contract.

Foundation ready for sill	1 month
Frame enclosed, chimney completed	2 months
Outside finish on	3 months and 15 days
Plastering	4 months
Interior woodwork	5 months and 15 days
Painter's work and completion	6 months

(Month and day to be inserted in contract and specification for each period mentioned above)

EXCAVATION, GRADING, ETC.

(NOTE TO STUDENT.—For this part of the work it is of advantage to draw a *lot plan*. This should show the system of drainage, which, if not included in the Architect's drawings, is often not very satisfactorily studied or understood. This part of the work, however, often depends on local conditions or customs in different towns, and for that reason is not made a part of the general contract. The drainage and water supply are often taken care of by the city or town authorities, the pipe being carried either to the lot line or to the outside of the building wall. The Architect has to ascertain what the system is, and to write his specification accordingly.

A datum* line (if not already given) should be established by the Engi-

* For convenience in engineering operations, there is established in each locality a *datum line*—that is, a horizontal line passing through a certain fixed

neer's level, at the sidewalk curb. This should be obtained for use in making the sketches and plans, and should be referred to frequently. If the first-floor level is determined in the studies with relation to this datum line—or "bench mark", as it is often called—the location of the building will be much more easily determined. If the lot plan is kept separate from the drawings, it can be contoured to show the different levels; and sections can be drawn on the margin to show the slope of the land. This plan can also be used for locating drainage and water and gas supplies.

The parts of the drawings referring to the excavator's work should be as carefully studied as those relating to any other part of the building operations. If possible, borings should be made on the lot before commencing the drawings, so that the character of the soil can be determined.

A few dollars spent by the Owner for borings on the lot and for a careful survey will be more than repaid by certainty in the excavator's estimate.)

Preparation of Site. The Contractor is to stake out the building, and to erect permanent batter boards at such points that they will not be disturbed during the construction of the foundations.

Clear lot for the building, removing soil and loam from site and 8 feet additional, and stacking it within 40 feet of the building where it may be used for final grading. Remove rubbish; cut down and remove any trees marked as condemned by Owner or Architect, and carefully protect all trees that are to be preserved.

Excavation. Excavate for all work covered by this contract, to at least one foot outside the cellar wall to the depth shown, and no deeper. This includes drains, dry wells and trenches, as well as cellar.

The dry well for refrigerator waste is to be 3 feet in diameter, 6 feet deep, with trench to same 5 feet deep and 8 feet long.

The trench under the cellar wall is to slope to drain cellar. No walls or piers are to start less than 4 feet 6 inches below the surface of ground.

Excavate for water pipe, gas, fresh air ducts, and for drain and cesspool about 40 feet from house. Excavate for piazza piers and for chimney footings.

Grading. After mortar of foundation walls is set, fill with stone and gravel to within 18 inches of finished grade; and after first-floor joists are set, complete filling, tamping every foot in height. Grade to level shown on drawings, so as to turn water away from building, using earth and top soil first removed.

Grade at completion as directed, removing loam where filling is called for, and covering with 12 inches of loam for lawn, and 18 inches depth of loam for shrub planting. For paths, where

point marked zero. Levels above this are marked thus, "+15", "+20", etc., which means that these particular points are 15 feet, 20 feet, etc., above the fixed point. In coast regions, this datum line is often fixed at low-water mark.

All city grades are figured from the datum line; and to establish such a line at a building is to fix a level at the required number of feet above the original. Thus, on the seacoast, the levels may run down to +10 or +18; while in Denver, which is at comparatively high altitude, is a datum line or bench mark + one mile (or +5,280 feet). In such localities it is usual to drop the first two figures and call the bench "+80."

shown, excavate 12 inches deep, fill with gravel made to crown 2 inches.

Care of Lawn. Sod for 2 feet on border of path and lawn, and 3 feet next to building. Lawn is to be leveled, raked clear of stones, and sown with best approved grass seed; it is to be properly watered and cared for until completion and delivery of building. Allow one hundred dollars ($100) for shrubs delivered, and plant same.

STONEWORK

Lime, Cement, and Sand. All lime is to be best quality Rockland or its equal, freshly burned; and all cement is to be first quality Portland. Brands are to be approved by Architect. All sand must be clean and sharp.

Mortar. Except where otherwise specified, the proportions are to be as follows:

Lime mortar—1 part lime to 3 parts sand
"Half-cement" mortar—1 part Portland cement, 1 part lime, 5 parts sand
Lime-Portland cement mortar—1 part Portland cement, 2 parts lime, 4 parts sand
Portland cement mortar—1 part Portland cement to 3 parts sand

Walls. The Contractor is to furnish all materials and to build wall and footings as shown on drawings, of good local stone in irregular courses, the first 12 inches to be laid dry in the trenches, and the remainder below ground to be laid in Portland cement mortar, the whole to be laid to a line on the outside face, and well bonded. The joints are to be thoroughly filled with mortar, and are all to be pointed inside and outside the whole height, holding the trowel so as to weather the pointing on the outside. There shall be at least one through bond stone to every ten square feet of wall.

The underpinning and all stone work above grade are to be laid in "half-cement" mortar, neatly pointed on the exterior with Portland cement mortar colored to match the stone, and to have ruled joints.

Carefully level the walls to receive the sills, and imbed in mortar. Cellar window sills to have wash formed with Portland cement.

Cement Coating. Mortar composed of 1 part Portland cement and 1 part sand, is to be applied to the outside of the wall below grade on the uphill side of building, from bottom to finished grade.

Cut out joints of exterior wall, where exposed above grade, ½ inch deep, and point neatly with Portland cement mortar, as described.

Drainpipe and Cesspool. The drainpipe is to be 5-inch, best glazed earthenware pipe, furnished and laid from cesspool to a point 5 feet outside cellar wall. Joints are to be filled with Portland cement. Connection is to be made by plumber.

Construct at a point about 40 feet from house two cesspools, as shown, one to be 4 feet, 0 inches in diameter, and 8 feet deep, with 8-inch brick walls, thoroughly cemented inside and out and made water-tight. Six feet from same, construct a leaching cesspool, 6 feet in diameter and 8 feet deep, made of loose stone, laid dry.

From iron pipe outside of building, connect house with cesspool by 4-inch Portland stoneware pipe. Also connect the two cesspools with Portland stoneware pipe, as shown.

The cemented cesspool is to have tight iron cover; the leaching cesspool is to have a ventilated iron cover.

Four-inch glazed earthenware pipe is to be furnished and laid from dry wells to one foot above ground, for conductor drains. Set iron pipe furnished by plumber to receive conductors.

Concrete Cellar Floor. Concrete is to be laid in the basement. Level off with coarse gravel; settle thoroughly, and put down 3 inches of concrete, composed, to the thickness of 2 inches, of 1 part Portland cement, 2 parts sand, and 3 parts clean, coarse, sharp gravel, well tamped; cover with 1-inch coat, composed of 1 part Portland cement and 2 parts sand; finish to true and even surface so that cellar will drain dry.

BRICKWORK

Except as otherwise specified, the brickwork is to be laid with hard-burned common brick, carefully selected for exposed work such as facing of chimneys above roof; all must be new, well shaped, and of uniform size. Bricks are to be laid wet in warm, dry weather, and dry in damp or freezing weather. All mortar to be lime-Portland. Joints are to be thoroughly flushed with mortar and well pointed. All outside exposed work is to be washed down after completion.

Chimneys. The chimneys are to be laid in Portland cement mortar. Build in lead counterflashing, at least 2 inches into the mortar joint, and turn down over the roof flashing.

Plaster the exterior of all chimneys where not exposed.

The *chimney caps* are to be of 2-inch blue stone, using only one piece to each chimney; the *flue holes* are to be cut through, and ½-inch smaller each way than the flue below.

All *flues* are to be lined with hard-burned terra cotta, 1 inch thick, set with very close joints filled with Portland cement mortar.

Terra cotta round *thimbles* are to be set for all smoke inlets; and in the ventilation flue, a square opening for a register is to be formed with square, smooth brick.

Fireplaces. Two 2-inch by ½-inch wrought-iron *chimney bars,* to support flat arches, are to be placed above each fireplace, 8 inches longer than opening.

Provide and build into bottom of each chimney one 8-inch by 10-inch cast-iron door and frame and set *clean-outs* to all flues.

Trimmer arches are to be turned for hearths on center of fireplace, and are to be 2 feet wide and of lengths equal to the hearths. Level up with cement to receive hearth.

Run 4- by 8-inch *ash flues* from first story fireplaces to ash pit.

Finished fireplaces are to be formed as shown in detail drawings—face, back, and fire bed of 1½-inch Philadelphia brick, with hearths of red, unglazed kitchen tile, or same as face. They are to have two 2- by ½-inch bars, cast-iron throat, patent damper and slide, and ash dump. After completion, each fireplace is to be kept protected. Samples of brick and tile must be submitted for approval.

Girder Supports. Set brick piers or iron columns in basement where shown, for support of girders, bricks to be laid in Portland cement mortar. If iron columns are used they are to be 4-inch and concrete-filled, with cast-iron caps and base plates.

LATHING AND PLASTERING

Lathing. Lath all walls, ceilings, and partitions (except behind sheathing in kitchen, but including all space behind all other sheathing and wainscots); also all furring, studding, soffits, and the underside of stairs throughout first, second, and third stories; also the laundry, head of stairs to basement, and cellar ceiling (but not where marked "unfinished" on the plans). Good spruce laths are to be used, set ⅜-inch apart and nailed with four nailings to a lath. Break joints every sixth course, and over all door and window openings. All laths to be put on horizontally. Metal lath over heater in basement.

Plastering. Plaster all above-mentioned lathing two coats.

The *rough coat* shall be the best, thoroughly slaked, pure eastern lime; clean, sharp sand; and best, long cattle or goat's hair, mixed in the proportion of 2½ bushels hair to 1 cask lime and 3 barrels sand, to be thoroughly worked and stacked outside of buildings at least ten days before using. Carry first coat to rough floor. All to be well troweled and straightened up with a straightedge.

The *skim coat* shall be sand finish, of white, well-washed sand, 3 parts sand to 1 part white lime putty, floated up with cork floats, and left medium rough; sample to be approved by Architect.

Whitewash. Whitewash all brick or stone work, etc., in basement, two coats, using good lime and plaster of Paris.

Metal corner beads (of approved make) to be furnished and set by plasterer throughout first floor, main house.

Cornices. Cornices are to be run in accordance with detail drawings:

Schedule—To be used in living room, parlor, dining room, hall.

METAL WORK

Flashings. Wherever roofs come in contact with vertical surfaces 5-pound lead flashings, 9 by 9 inches, are to be built into each shingle joint and turned up onto the vertical surface at least 5 inches. Over these flashings, counter-flashings are to be placed, built into the brickwork as above specified; or, where the vertical surfaces are of shingle or siding, they are to extend under such surfaces at least 6 inches.

Valleys. All valleys are to be lined with 5-pound lead extending 6 inches under shingles at each side.

Eaves-Trough and Conductors. The eaves-troughs and conductors are to be of No. 26 galvanized iron, the conductors to be crimped 3 by 4 inches and connected 6 feet above ground with the 4-inch soil pipe to drain.

All work in connection with the eaves-troughs and conductors is to be riveted when possible, and all joints soldered; and the expansion and contraction from changes in temperature is to be guarded against by expansion joints or loose ends.

CARPENTER WORK

Framing

The building is to be full frame, and framed, braced, spiked, and pinned in the best and strongest manner, perfectly true and plumb. Filling-in studs shall be nailed, and door and window caps cut into studs. No woodwork shall come within one inch of a chimney; and framing must be arranged to avoid cutting for pipes, chimney, etc. Truss all openings over 3 feet wide.

Timbers. *Quality.* The timber, except where otherwise specified, is to be of spruce. All timber throughout the building to be full and square to the dimensions indicated, well seasoned, and free from large or loose knots, sap, shakes, or other imperfections impairing durability or strength.

Dimensions. Dimensions are to be as follows:

Sills, 6 by 8 inches
Girders, 8 by 10 inches
Posts, 4 by 8 inches
Girts, 4 by 8 inches
Ledger boards (used only in subordinate framing), 1 by 6-inch hard pine
Braces, 3 by 4 inches long
Studding, 2 by 4 inches, 16 inches on centers
Door and window studs, double, 2 by 4 inches
Door and window heads, 3 by 4 inches
Partition caps, 2 by 4 inches, hard pine
Partition soles, 2 by 4 inches
Joists, first and second floors, 2 by 10 inches; attic, 2 by 8 inches, 16 inches on centers
Plate, 2 by 4 inches, double, breaking joints
Rafters, 2 by 8 inches, 20 inches on centers
Valley rafters, 3 by 10 inches
Ridges, 2 by 8 inches
Piazza and porch girders, 4 by 8 inches
Piazza and porch sills, 4 by 8 inches
Piazza and porch floor beams, 2 by 8 inches, 20 inches on centers

Sills. Halve (or frame and pin) sills at angles. Frame corner posts and door and window studs to sill and girt. Floor beams are to be notched down on sill, and gained in.

Joists. Double the joists under all partitions not over partitions below running parallel with the joists, where supports to span are 10 feet or less; under all others, triple the joists.

Headers and Trimmers. Double all headers and trimmers 8 feet long or less; triple all longer ones.

Bridging. Bridge all floors every eight feet with 1- by 3-inch pieces, cut diagonally and double-nailed at each end.

Studs. All studs are to be 2 by 4 inches, 16 inches on centers, straight and plumb. Partitions directly over walls and girders in cellar, or with partition caps below, are to run down to rest on them. Strongly truss all partitions not supported from below. Spike studs at corners. Set studs of sliding door pockets on heavy paper and line pockets with ½-inch matched sheathing with tight joints.

Piazza Joists. Piazza joists are to pitch 1 inch in 5 feet away from the houses.

Main Roof. The main roof is to be framed in the strongest manner, with valley rafters carried to the ridge or hips. All hips and ridges are to be maintained perfectly straight. Rafters are to be notched over the plate and spiked. Double the rafters at

each side of dormer openings; 4- by 8-inch header, 8 feet above top floor. Partitions are to be carried up to support the roof wherever practicable. All are to be thoroughly tied, and made perfectly secure and strong. Collar beams are to be 2 by 6 inches, 8 feet 2 inches above attic floor.

Dormers. Dormers are to be framed with 4- by 4-inch corner posts, 2- by 4-inch studding and plate, and 2- by 6-inch rafters. The studding is to be notched 1 inch on rafters and to extend to the floor.

Boarding. Cover all roofs and frame walls with good, sound spruce boards not over 10 inches wide; roof is to be square-edged, the walls to be matched and laid diagonally. Cover walls with "Neponset" black sheathing paper, or its equal.

Shingles. *Roof.* Cover all roofs with "extra" sawed cedar shingles, laid 5 inches to the weather, with two nails to each shingle. Double-shingle all hips. The ridge is to be finished with 6- by ⅞-inch saddle boards.

Walls. Cover all walls with "clear" sawed cedar shingles, 5½ inches to the weather.

Exterior Finish

All exterior finish not otherwise specified is to be worked from good cypress, clear of sap, shakes, and large or black knots, following elevation and detail drawings; and to be put up in a skilful manner, with close joints and with nails sunk for puttying. Joints exposed to the weather are to be matched and painted with thick white lead before putting the pieces together. The painter is to prime finish before or immediately after putting up.

Main Cornices. Main cornices are to be according to detail drawings, with 5- by 7-inch cypress gutter, fascia, plancier, rebated 1¼-inch belt above clapboards, moldings, dentil course, and brackets.

Cellar Hatchway. Cellar hatchway is to have 2-inch plank treads on 2-inch carriages, 16 inches on centers; 2-inch plank sills, and trapdoor frame, bolted to masonry. Case with ⅞-inch cypress, and make doors of narrow cypress, the doors to be well cleated. Make water-tight. Put on heavy strap hinges and proper fastenings. Build single door at foot of stairs.

Porch and Piazza. *Floors.* The floors of porch and piazza are to be laid with ⅞-inch by 3-inch Georgia pine, dressed on one side, the upper edge eased off; laid ⅛ inch apart, and nailed with 8-penny nails. Finish with rounded nosing and ⅞-inch by 1-inch moldings. Floors are to pitch to throw off water.

Outside Steps. Steps are to be constructed with 2- by 10-inch plank carriages, 16 inches on centers.

Treads of outside steps are to be of 7/8-inch by 4-inch hard pine strips, with rounded nosings and coving under, returned at the ends. Risers are to be 7/8-inch thick.

Ceiling. Ceiling of covered porch and piazza to be of 5/8-inch by 2½-inch tongued, grooved, and beaded North Carolina pine.

Columns. Columns are to be built up of white pine, with turned shafts of diameter as shown for lower third, diminishing slightly above, with molded caps and molded bases.

Balustrade. At floor and at roof of porch and side piazza, and over dining-room bay, there is to be a balustrade, the balusters to be of 2¼-inch stock, 2 inches apart, turned.

Posts. Posts on porch and piazza roofs are to be built up with turned finials, and supported by pieces running up from the plate or sill inside of posts.

The top rail is to be built up and molded; the lower rail, 2 by 3 inches, is to be solid and beveled.

Window Frames. Plank frames in stonework in basement, except where shown double-hung, are to be of 1¾- by 6-inch pine, with 7/8- by 1¾-inch molded staff bead, and 2¾-inch sill. Frames are to be rebated on the outer edge for screens. Sash is to be hung at the top, to swing in.

All windows shown with meeting rail, unless otherwise specified, are to have pine frames made for double-hung sashes, with 7/8-inch hard pine pulley stiles, tongued into outside casings, beads, ¾-inch ground casings, 1⅜-inch yokes, 2¾-inch sills to pitch 1½ inches, 7/8-inch by 5-inch outside casing over boarding, with 1¾- by 2¼-inch back window caps, as shown. Windows are to have 2-inch bronze-faced axle pulleys.

Scuttle. The scuttle is to be 2 by 2 feet, with plank frame 6 inches high. Heavy strap hinges and fixtures are to be applied that will hold the cover at any angle. Frame and cover are to be tinned.

Door Frames and Doors. *Frames.* The frames are to be made from clear pine stock, 1⅞ inches thick, rebated and beaded on inner edge, and with 1¾-inch hard pine thresholds. The casing of outside door frames is to correspond with windows.

Sash. Sash is to be of white pine, unless otherwise specified. In the first story, it is to be 1¾ inches thick; in the second and third stories, and all of the ell, 1½ inches thick; in cellar 1¼ inches thick. Large one-light sash are to have 1½-inch meeting rails. Sash is not to be stained.

Doors. Doors, except stock doors, are to be paneled and molded according to scale and detail drawings. All panels are to be loose, and not glued or nailed. Tenons are to have ¾-inch haunches.

Outside veneered doors shall be 2¼ inches; doors 3 feet wide and over, shall be 2 inches thick; all others, 1¾ inches thick.

Front and Rear Hall Doors. These are to be 2¼ inches thick, of white pine, veneered inside to match vestibule; lower panels are to be raised, and upper panels glazed with double-thick glass.

Other Outside Doors. All other outside doors except cellar door shall be of 1¾-inch pine stock sash doors, as shown, with wood muntins, glazed with double-thick glass. Build cellar door of ⅞-inch stock.

Blinds. Blinds are to be hung for all windows. They are to be of cypress or of white pine, 1⅛ inches thick. Mark each blind to correspond with the mark on the window opening.

Screens. The Contractor shall furnish and set screens for all outside doors and windows that open; they shall be made from the best clear, thoroughly seasoned white pine, ⅞-inch thick, and shall be stained and varnished with three coats. Screens are to be fitted with lifts, springs, and runs, so that they can be used for either upper or lower half of sash, with adjustable run.

Wooden frames are to be covered with 14-mesh best approved galvanized wire, and door frames and cellar windows with 13-mesh wire.

Grounds and Furring. Fur ceilings and rafter in the finished portion of the attic with 1- by 2-inch spruce furring strips, 12 inches on centers, nailed to every beam; and fur out in finished attic rooms for 3-foot 6-inch walls; also for plastering next to basement walls, with 2- by 4-inch studding, set flat.

Put grounds for ¾-inch plastering around all door and window openings where there is no ground casing, and for base, wainscot, wood cornice, etc., as directed. Put two grounds behind base.

Interior Finish

Materials and Their Treatment. *Stock.* All stock is to be of the best quality, unless otherwise specified, free from knots or sap, thoroughly seasoned or kiln-dried. All must be smoothed, scraped, and sandpapered by hand before putting up, and at completion; such work as is to have a natural finish must be properly cleaned. No interior finish is to be taken into building until the plastering is dry.

Priming Back of Finish. Back of standing finish is to be given a priming coat by the Contractor who furnishes the interior finish, before it leaves his shop.

Curved Finish. All curved finish is to be spring on or worked from large stock, so that no kerf marks can be seen.

Finish for Main Part of House. All finish on main part of house, except inside of closets, is to be molded.

Finish for Service Parts of House. All parts of the building devoted to service, and the inside of closets, are to have flat finish.

Wainscot Sheathing. North Carolina pine, 4 feet high, is to be set in the back entry, the kitchen, and the bathroom; it is to be matched and beaded like approved sample, 7/8 inch by 2½ inches, with 1½-inch rebated cap and no base.

Paneled Wainscot. This wainscot is to be paneled, as shown, with raised panels; to be 3 feet high, have a 6-inch base, and a molded cap, 7/8-inch rails and stiles, and loose panels.

Schedule—To be used in dining-room.

Birch. Unless otherwise specified, all birch is to be the best selected, first-quality red birch, of even color.

Schedule—To be used in dining-room.

Oak. Unless otherwise specified, all oak is to be the best selected, thoroughly seasoned American quartered white oak; it shall show good grain, and be free from shakes, knots, stains, or any other imperfections.

North Carolina Hard Pine. Unless otherwise specified, the North Carolina hard pine used is to be of selected first quality.

Schedule—To be used in back entry; kitchen; pantry; china closet; bathroom.

Picture Moldings. Picture moldings, 1⅛ by 2½ inches, and of the same wood as the finish, are to be run around principal rooms of first story; around all chambers of second story, main house, moldings, 7/8- by ¾-inch and matching finish, are to be run. Unless otherwise directed, the molding is to be 1 foot 6 inches below ceiling, and where there is a cornice, ½ inch below cornice. The picture molding is to be finished by painter before putting up, except for the last coat.

Door Frames and Doors. *Frames.* All inside swinging doors are to have 1¾-inch double-rebated and beaded frames of pine or whitewood to match adjacent finish. Veneer for other woods with ¼-inch veneer on 1¼-inch pine.

Doors. Doors, except stock doors, are to be paneled and molded according to scale and detail drawings. All panels are to be loose and not glued or nailed. Tenons are to have ¾-inch haunches.

Doors not veneered are to be of solid pine, whitewood, cypress, or birch, to match room.

Doors in rooms having hardwood finish are to have thoroughly kiln-dried, white pine core, with solid moldings and ¼-inch veneering of kiln-dried wood ¾ inch on edges, well glued on both sides to match hardwood finish of rooms. If one of two adjacent rooms is to be painted, veneer door with hardwood of other room, on both sides. All panels over 15 inches wide to be glued up.

Stock Doors. Stock doors are to be 1¾ inches thick, stock sizes, with plain panels and flush moldings on both sides, and to have 4 panels. Architect must approve sample showing quality and arrangement of panels.

Sliding Doors. Sliding doors are to have astragal joints at center, and ⅝- by 1¼-inch friction mold all around; to slide on "Richards" or other approved patent hangers, on birch track.

Dwarf Doors. Dwarf doors for wardrobes, cupboards, pantry, etc., are to be solid paneled, 1¼ inches thick.

Closets. *Clothes Closets.* Each closet is to have a high shelf, and strips all around for clothes hooks. Unless otherwise directed, shelf is to be ⅞ inch by 14 inches, and 5 feet 10 inches above floor, with hook rows at 4 feet 6 inches and 5 feet 6 inches above floor.

Linen Closet. The linen closet is to have a counter shelf with four drawers below; shelves above, 16 inches apart, extending to ceiling, to be fitted with doors hinged at the bottom to drop down.

China Closet. The china closet is to have a counter shelf 2 feet 8 inches above floor; underneath, paneled, hinged doors and eight drawers, one drawer subdivided; above, hinged, glazed doors and five shelves. There is to be a frame for the sink, and a high closet over the sink with glazed doors and three shelves. There must be 8 inches clear space over counter shelf.

Pantry. The pantry is to have a counter shelf, as shown, 2 feet 8 inches high, with 47⁄8- by 14-inch shelves above and four drawers below, one drawer being divided for knives, etc.; space for two flour bins with doors; remainder of space to have shelving enclosed by sheathed doors. All this is to be of clear white pine or whitewood, for natural finish.

Broom Rack. A broom rack is to be put up in broom closet or in cellar stairway; it is to have cast-iron holders for sweeping and whisk broom, dustpan, fire bucket, etc., which holders or fixtures are to be included in the hardware.

Tank in Attic. In the attic a tank, 4 by 4 by 2 feet, is to be built of 2-inch plank, tongued and grooved, fastened together with iron rods and nuts, and well cleated.

Plumbing Strips. Plumbing strips are to be put up to support pipe where required by plumbers. Water closet seats and tanks, except in attic, are to be furnished by plumber.

Mantels. Allow a total sum of one hundred twenty-five dol-

lars ($125.00) for wood mantels delivered at house, to be selected by Owner, set by carpenter, and finished by painter.

Floors. *Under Floors.* Lay under floors, except in basement, of good square-edged spruce boards, surfaced on one side to even thickness, and nailed to every bearing with two 8-penny nails. End joints are to be cut over beam in every case.

Sheathing Paper. Lay two thicknesses of approved sheathing paper between the under and finish floors.

Finish Floors. The upper floor is not to be laid, where there are double floors, until standing finish is all in place. All lining floors are to be thoroughly repaired and cleaned before finish floor is laid.

Oak Floors. For first floor of main house, except in kitchen, the floors are to be of matched quartered-oak flooring, ⅞ inch by 2½ inches, clear, thoroughly seasoned, and kiln-dried; to be blind-nailed to every bearing with 8-penny nails, laid over rough floor, planed off, scraped, and sandpapered, ready for finishing. Protect properly.

Hard Pine Floors. Hard pine floors are to be laid in kitchen, pantries, and bathroom, to be of ⅞-inch by 2½-inch matched rift Georgia pine.

Hardware. The sum of one hundred fifty dollars ($150.00) is allowed for all trimmings of doors and windows, and fittings in china closet, pantry, closets, drawers, etc., allowance to cover *net* cost to Contractor; Architect or Owner is to select hardware where he chooses; and Owner is to have benefit of any deduction from allowance. Carpenter is to furnish correct list of hardware, and to put it on carefully and in workmanlike manner.

PAINTING

Miscellaneous Requirements. *Samples.* Samples of all colors shall be submitted for Architect's approval.

Knots and Defects. Sap, pitch, knots, and similar defects shall be covered with good-quality shellac.

Number of Coats. Unless expressly so indicated, priming and shellacking are not to count as coats in this specification.

Exterior Finish. All dressed exterior finish, blinds, and sash, are to be painted two coats, after priming, of white lead and linseed oil.

Hard Pine. Pulley stiles and floors, and steps of porches, are to receive two coats oil, well rubbed in.

Schedule. Following is a general memorandum of exterior painting. This is to be compared with plans, and all work is to be left with painter's finish complete.

Finish, 2 coats paint after priming
Porch floors, 2 coats oil
Blinds, 3 coats
Metal, 3 coats
Shingles, natural

Inside Finish. Except where otherwise specified, all inside finish is to be well filled, and is to have one coat of stain and shellac and two coats of dead hard oil finish. All work about kitchen and bathrooms is to have two coats of hard oil with high gloss.

Ivory White. Where indicated, give 1 coat shellac, then 3 coats lead and oil paint, sandpapering each coat; then 2 coats white lead, zinc, and white varnish, rubbing down with pumice stone and oil. Sample and tint shall be approved.

Whitewood. Whitewood and other finish, unless otherwise specified, are to have 3 good coats lead and oil, color as approved; last coat is to have suitable proportion of zinc, and to be left with flat or oil finish.

Hardwood. Treat hardwood finish according to best methods with potash; give 1 coat of oil or paste filler; clean off; give 4 coats of white shellac, sandpapering after each coat except last, which is to be rubbed to dull finish with pumice stone and oil.

Enamel White. Give 1 coat shellac; then 4 coats lead and oil paint, sandpapering each coat; then 2 coats white varnish, rubbed each with pumice stone and oil, sample to be approved.

Standing Hard Pine Finish. Standing hard pine finish is to be given 1 coat approved primer and filler, sandpapered; 1 coat approved inside spar varnish, rubbed down; and 1 coat approved inside spar varnish, flowed on.

Schedule—To be used in kitchen; pantry; serving-room; bathroom.

Bathtub. Bathtub is to be painted outside, 4 coats; the last coat to be an enamel gloss coat.

Exposed Piping. All piping that shows is to be given 1 coat of white shellac.

Plastered Walls and Ceilings. Plaster walls, except in bathroom, and ceilings, except in kitchen, pantry, china closet, and bathroom, are to be painted 1 coat sizing and 3 coats paint, last coat to contain varnish to leave gloss. All ceilings are to be sized and tinted.

GLAZING

Plate Glass. Furnish and set ¼-inch American polished plate glass for large lights in main house.

Double-Thick Glass. All glass not otherwise specified is to be first-quality double-thick German or American glass.

At completion, all glass is to be thoroughly cleaned of oil, putty, paint, mortar, and plaster, and to be left whole.

HEATING

Furnace. Provide and set up complete, where shown on plans, a hot-air furnace of *approved* make, to be of *cast iron,* with stated and sufficient area of grate and heating capacity to keep building at 70 degrees Fahrenheit, when thermometer is at zero outside.

Piping System. *Smoke Pipe.* The smoke pipe is to be 9-inch black iron pipe, fitted with close-fitting damper, also a check damper, and proper cleanouts.

Tinwork. Furnish and set warm-air pipes and register boxes, of bright IX tinplate. Mark each pipe with the name of room it supplies. Cover risers with metal lath in partitions before plastering.

Dampers, Collars, etc. The dampers for warm-air pipes, netting for register boxes, tin collars, casings, lining tin for protection from fire are all to be supplied and set by Contractor.

Cold-Air Box. The cold-air box is to be of No. 24 galvanized iron, with all joints riveted tight, and with such bracing as will effectually prevent the sagging of the top. It is to be fitted to the cold-air inlet and at delivery inlet, and is to have a balanced, close-fitting damper which, when open, will give full passageway for air.

Registers. Furnish registers and connect to pipes, with valves in each. Registers are to be of black Japanned cast iron, with tin boxes and borders. In the library, register is to be bronze; in the reception room, of white enamel, of approved quality and design.

Schedule—Registers are to be laid out according to an approved schedule submitted by each bidder, showing size, finish, etc., for each room, with size of supply pipe. Locations are to be as shown on plans or as approved in building, before proceeding with work.

PLUMBING

Piping and Connections. *Materials.* All drain, soil, waste, and vent pipes, and all fittings, are to be extra heavy plain cast iron, painted outside two coats red lead.

Joints. All joints in cast iron pipe are to be made tight with oakum and lead, well calked.

Lead Pipes. All lead, waste, and vent pipe branches are to be of best quality drawn lead, of the following weights per foot:

1½-inch	3 lb.
2 -inch	4 lb.
3 -inch	6 lb.
4 -inch	8 lb.

Connections. All connections of lead and iron pipes are to be made by heavy brass ferrules, same size as lead, calked with lead.

Joints between ferrules and lead pipes are to be wiped; all lead pipe joints are to be wiped.

Pipe Supports. All vertical lines of soil and waste pipes, if not carried to drain below cellar floor, are to rest on brick piers at their base.

Iron Pipes. All vertical lines of iron pipe are to be held in place by pipe hangers or wrought-iron clamps, placed 5 feet apart. In horizontal lines, they must be not more than 10 feet apart.

Lead Pipes. All lead pipes are to be secured in place with metal tacks or brass clamps, placed 3 feet apart; and horizontal pipes are to be supported their entire length by carrying strips.

Brass Pipes. All brass pipes are to be secured by brass pipe holders, approved by the Architect.

Miscellaneous Piping Requirements. *Pitch of Pipe.* All horizontal drain and waste pipes are to have a fall of not less than ¼ inch to the foot.

Angle of Connections. All changes in direction must be made with Y (45 degrees), ⅛ (22½ degrees), or $\frac{1}{16}$ (11¼ degrees), branches.

All connections with horizontal pipes must be made by Y branches. TY's (sometimes called "Sanitary T's") may be used on vertical pipes.

Brasswork. All exposed brasswork is to be nickel-plated, except in basement and kitchen, where it is to be polished.

Cleanouts. Set Y's with extra heavy brass screw caps at each bend in horizontal lines, and 15 feet apart in straight lines; also set cleanouts at ends of all horizontal lines.

All cleanouts are to be the same diameter as the pipes with which they are connected.

Traps and Vents. Every fixture must be separately trapped. No traps are to be less than 1½ inches in diameter. Each set of trays must have one trap.

All traps must be vented—4-inch traps by 2-inch branches, 2-inch and 1½-inch traps by 1½-inch branches.

Roof Flashings. All joints between the roof and iron pipes must be made tight with 6-pound lead or 16-ounce copper flashings.

Drains, Soil and Waste Pipes. The plumber shall make proper connections from a point 10 feet outside of building, with a drain, by 5-inch iron pipe.

Just inside the house wall, place a 5-inch running trap with two cleanouts; and run a 5-inch fresh-air pipe from house side of trap to a point not less than 15 feet from building, opening one foot above ground, with return bend.

Continue drain 5 inches in diameter under cellar wall, and connect the various soil and waste pipes with same.

The trap on the main drain must be placed in an accessible brick manhole, with 8-inch walls, and be covered with stone or iron cover; and the drain pipes must be laid in a brick trench with stone or iron cover.

Set, where shown on plans, lines of 4-inch soil pipe, or 2-inch waste pipe, as necessary, with proper connections to receive the various fixtures. Carry the pipe through roof, and one foot above same, increased one inch in diameter from a point below roof; ends above roof are to be left free and unobstructed.

For each line of fixtures, set a 2-inch pipe, with fittings for the various vents. Connect with soil pipe below lowest fixture, and at top well above highest fixture.

All waterclosets are to have 2-inch local vents of nickel-plated copper connected to 3-inch spiral galvanized pipe, carried to chimney, as directed by Architect. All joints in pipes are to be soldered tight.

Under the refrigerator, place a copper-lined box, 12 by 8 by 6 inches. Carry 1½-inch lead waste pipe from box to basement. with end turned up so as to form a water-sealed trap, and capped with light flap valve, to waste into sink or other receptacle provided for the purpose.

Tests. The water test must be applied to the entire system of piping, in the Architect's presence and to his satisfaction. All pipes and connections must remain uncovered until they have passed the test.

On completion of the work, after all fixtures are set, the smoke test will be applied, and must prove satisfactory to the Architect.

Fixtures. *Watercloset.* Waterclosets are to be installed as follows:

In basement—one washdown closet, with metal outlet of approved pattern, and with oak seat (no cover) attached to bowl with heavy hinges. The tank is to be a plain 12-ounce copper-lined siphon tank with cast-brass gooseneck, valve, high-pressure ballcock, iron brackets, chain and pull, and 1½-inch brass flush pipe. Brass work is to be polished.

In bathroom—one siphon-jet closet, with water-covered outlet connection between earthenware and waste pipe; 1¼-inch cherry seat and cover, with heavy hinges, attached to bowl. The tank is to be a cherry service tank, 8 gallons' capacity, with brass brackets,

high-pressure ball cock, and 1½-inch flush pipe. Brasswork is to be nickel-plated.

Lavatory. In the bathroom there is to be installed one 22-by 27-inch enameled-iron lavatory, with back and apron in one piece, supported on concealed wall hangers; it is to have heavy, low-down pattern compression cocks, disc handles, ½-inch iron-size brass supply pipes, and 1½-inch deep-seal S-pattern trap. Brasswork is to be nickel-plated.

Bath. In the bathroom there is to be installed one 5-foot guaranteed quality, 3-inch roll-rim, enameled-iron bath, flat bottom, approved pattern; it is to have ¾-inch heavy combination compression cock, disc handles, ¾-inch supply pipes, 1½-inch connected waste and overflow pipes, and plug and chain. Outside of bath is to be finished by painter. Bath is to waste through 1½-inch bath trap set in floor.

Sinks. Sinks are to be installed as follows:

In kitchen—one 36- by 24- by 8-inch soapstone sink, with 12-inch back, and soap dish, set on galvanized-iron standards. Sink is to waste through 6-inch lead trap, and to be supplied through ¾-inch compression bibs; hose end on cold cock; brasswork to be polished.

In china closet—one 24 by 14-inch recessed, 18-ounce, tinned-copper sink, with 1½-inch standing waste and overflow. Waste is to be the same as in case of kitchen sink, and supply through tall gooseneck with heavy pattern compression cocks; hose end on cold cock; brasswork to be nickel-plated.

Wash Trays. In the laundry there are to be two 24-inch soapstone trays, with 12-inch back, and soap dish, plugs and chains. Trays are to be set on galvanized-iron standards.

Range Boiler. Range boiler is to be of copper, 40 gallons' capacity, on galvanized-iron stand, and connected with range by ¾-inch brass pipe.

All fixtures except water closets are to be supplied with hot and cold water.

Water Supply. *Materials, etc.* All cold-water pipes and fittings are to be of galvanized iron; and all hot-water and circulating pipes are to be iron-size brass, semi-annealed, with all fittings of brass.

Where exposed, brass or nickel-plated pipes are to be supported by brass or nickel-plated hangers.

All exposed supply pipes in bathroom and toilet rooms are to be nickel-plated brass, semi-annealed; in kitchen, polished brass.

Stops and Wastes. All risers are to have stop and waste, roundway same size as pipe, in accessible position in cellar, and properly tagged.

All supply pipes and branches shall have proper pitch so that they may be readily emptied at their lowest point; and each branch supply of fixtures shall have compression stops, with stuffing box close to cocks.

Size of Pipes. Make connection with water main in street by ¾-inch, 4-pound lead pipe; and carry same into building. Just inside wall, place a ¾-inch "Simplex" stop, with ¾-inch stuffing box hose bib on house side. From stopcock, carry galvanized pipe along on basement ceiling, and take branches to supply various fixtures, as may be necessary.

From ¾-inch main, take branches as follows:

For risers	¾ inch
For sill cocks	¾ inch
For tank in attic	¾ inch

Supplies to fixtures shall be as follows:

To lavatory and watercloset tanks	½ inch
To baths, sinks, and wash trays	¾ inch
From tank in attic to hot-water boiler	¾ inch

Attic Tank. In attic, where directed by Architect, line a 4- by 4- by 2-inch tank with 14-ounce tinned copper, fitted with ¾-inch high-pressure ball cock and proper valves. Overflow is to run to roof or to laundry traps in basement, as may be directed by the Architect.

Set, where directed by Architect, two ¾-inch nickel-plated wheel-handle sill cocks, with stuffing box. Inside of wall, place a ¾-inch "Simplex" stop and waste.

Hot Water System. Connect hot-water boiler with tank by ¾-inch pipe. Carry ¾-inch brass pipe from boiler, with branches as specified to supply the various fixtures, and ½-inch brass return to boiler. The entire system must circulate freely and thoroughly.

From highest point of system, carry ½-inch expansion pipe to tank, discharging over top of same. Place stop cocks on supply to boiler and from same.

GASFITTING

Provide and put in gas piping according to this specification, and as shown on plan, according to the rules of the local gaslight company.

The cutting is to be done by the carpenter, not by the gasfitter. No floor beams are to be cut farther than 2 feet from bearings.

Piping. Piping is to be of wrought iron; fittings are to be of galvanized malleable iron, set with red lead, firmly fastened.

Make sure that pipe is free from obstructions, before placing in position. Gasfitters' cement must not be used.

Following is the scale of sizes of pipes and number of burners (not outlets) to be supplied therefrom:

Longest run (ft.)	20	30	50	70	100	150
Size of pipe (in.)	⅜	½	¾	1	1½	2
Number of burners	2	4	15	25	40	70

Testing. Piping is to be tight under a pressure of air equal to a column of mercury 6 inches high, mercury to stand without failing for half an hour. Outlet caps are to be loosened to show that they affect testing apparatus, and that there is no obstruction in pipes.

VACUUM CLEANER

Provide, install, and connect up complete in first-class operative condition, to the approval of the Architect, a vacuum cleaning machine of one sweeper capacity, for the purpose of removing dust and other foreign matter from carpets, rugs, cushions, upholstery, floors, walls, and other interior surfaces. The vacuum cleaning machine shall include all mechanisms incidental to the complete and perfect operation of the system, and all equipment shall be of the most recent and perfected design.

The contractor shall install the machine, as herein specified, and all piping required to make the system complete, including cleaner mains, risers, and exhaust pipe. All electrical connections are to be made by owner.

Permits. The Contractor shall obtain permits, arrange for inspection, and furnish without cost to owner all certificates of inspection required by the city or local authorities on the entire equipment.

Foundation. A substantial floor shall be provided by Owner in the room in which the vacuum cleaner machine will be located.

Equipment. *Vacuum Cleaning Machine.* The Contractor shall furnish and install, where shown on plans, one No. —— Vacuum Cleaner.

Tools. The Contractor shall furnish one set of tools as follows:

1 Carpet or rug renovator
1 Felt bare-floor sweeper
1 Renovator for upholstery, portieres, clothing, etc.
1 Renovator for tuft cleaning
1 Duster

Extension handles sufficient for use with above tools, and such that walls, ceilings, or hangings can be easily reached from the floor

All tools must be well made, durable, and of polished aluminum or nickel-plated finish.

Furnish two 25-foot lengths non-collapsible vacuum hose, of not less than 1 inch inside diameter, and having smooth inside surface. The hose is to be the best quality, reinforced in a manner to prevent collapse at highest vacuum obtainable with the pump furnished.

Each length of hose and each extension handle must be equipped with a quick-acting coupling. Simple slip joints will not be acceptable.

Piping. Provide and install piping for vacuum cleaning system, located as indicated by the Architect, and consisting of two vertical risers of 1½-inch pipé, and necessary horizontal mains, connecting the risers with the vacuum cleaner. The exhaust pipe from the vacuum cleaner is to be carried into a vent flue or to an unobjectionable point outside the building, as indicated by the Architect, and to be of the same size as connection provided for it on vacuum cleaner. The pipe used must be of standard weight, with smooth inside surface, free from dents, kinks, fins or burrs. The ends of all pipe are to be squared and reamed smooth to the full inside diameter. All piping and joints must be thoroughly tested and guaranteed free from leaks.

Fittings. All fittings must be those known as "drainage fittings," made of gray cast iron, free from defects, having inside diameter through body of same size as pipe bore; long-turn tees and elbows to be used. All openings in fittings receiving inlet couplings are to be 1½ inches, pipe size.

Pipe-Joint Paste. In the installation of the piping, under this specification, pipe-joint paste, red or white lead, must be applied only to male threads of pipe and fittings.

Hangers. Horizontal overhead pipes are to be supported by suitable pipe hangers, spaced not more than 12 feet apart.

Cleanout Plugs. Brass cleanout plugs, of same size as pipe, are to be provided in horizontal mains at turns and at base of risers.

Inlet Couplings. The following openings are to be equipped with inlet couplings:

Basement, 1	First story, 2
Second story, 2	Third story, 1

Decorating. All exposed piping in finished rooms is to be decorated with paint or bronze, two coats, as directed by the Architect.

SPECIFICATIONS FOR CITY WORK

While many of the preceding requirements relate to both country and city construction, there are certain details that are peculiar to each, so that a specification adapted to city work will next be considered.

PRELIMINARY STUDIES

For illustrations in connection with the following pages, the construction of a city house is selected, on a corner lot fronting 100 feet on the avenue, and 150 feet deep on the side street, a party wall on the inside line. The house is to come out to the avenue sidewalk line, with coal vaults under sidewalk. The avenue in front is paved, with curb and sidewalk in place. There are no improvements of this character on the side street.

Study of Drawings. A careful outline of what the specification is to treat should be made before any of the actual writing is begun; and inasmuch as the scheme has been developed on the drawings, and the only object of the specification is to supplement these, a most careful study of the drawings should be made, keeping in mind the question of conditions and materials. Notes should be taken of the different classes of subjects which will supply the headings for the specification; and very largely on the arrangement and completeness of these notes will depend the success of the specification, which should never be begun until the last note is taken and the whole arranged in proper sequence.

Study of Site. With the completed scheme in mind, the site is visited and studied as carefully as were the drawings. It is found that a fence is necessary to prevent careless teamsters from driving over the adjoining property. The curb and sidewalk have been placed under the direction of the city authorities, and they must be carefully protected. There is a large tree on the lot, which, with two in the street, must be saved. In matters of this kind it is useless to stipulate that the contractor is to be responsible for any damage to the tree, and then leave it unprotected. After some teamster has damaged it, there is nothing the contractor

can do to put it back or to pay for the damage. Definite means of protection should be included in the contract work. There will be little use to try to preserve sod or shrubs. When the work is completed, it will usually be found that the grades are changed just enough to destroy the sod, and that the shrubs had better be located elsewhere. All the room on the lot will be valuable to the contractor for working space and piling material, and this point he will not fail to take into account in making his bid; or—to put it otherwise—if he is confined to narrow quarters and required to protect the grass and shrubs, he will add a round figure for the additional work and inconvenience.

Study of City Regulations. The city authorities must be consulted relative to the amount of roadway which may be used, the guards required in the way of barricades, temporary sidewalks, and red lights at night.

The questions of where the sewer and the water main are to be tapped must be settled; and it is usually better to have both connections made under a special contract before any work is done under the general contract, as the sewer will possibly be needed to keep storm water from the excavated space, and water will be needed at once for masonry work. If the street has been paved, it is probable that both sewer and water main have been brought to the curb.

Study of Soil. It will be of advantage, if, at this point, the owner will have three or four small test holes dug. Borings are of doubtful value; and often, in uncertain soil, a great additional expense is entailed after the award of the contract on account of necessary substructure work. Not infrequently clauses are inserted in the specifications, requiring the contractor to be responsible for any bad spots found, and to do all necessary work to make them good, so that test pits are considered unnecessary. Since, however, under such conditions, the contractor will always figure for the worst conditions, and the owner pays for it, it is better to know definitely the kind of bottom that will underlie the building. In digging these pits, the knowledge of the various kinds of soils to be encountered will be of value. The specification writer can estimate with certainty then how much material can be used for filling and grading of the lot, and how much worthless mate-

rial must be hauled away. If any sand is encountered, tests should be made to determine its value for mortar.* This knowledge will have its influence on the bidders in making up their proposals.

It is not here presumed that the case under consideration involves extensive protection of adjoining walls, or that excavation is to be carried below, or that shoring must be done. Such cases are comparatively rare; and, as each instance involves questions not of a general nature, it is outside the scope of a paper of this character to discuss this phase.

STUDIES IN MATERIALS

Since the primary object of this paper is instruction, there are introduced here certain problems relative to the particular qualities of the material under consideration. Special attention is called to the fact that these problems are not intended merely to illustrate the qualities of the particular material, but to indicate lines of *thought* to be followed in considering *every* material.

There are a great many things taken for granted in connection with building material—many old beaten paths which lead one from tradition to nowhere. The sooner the specification writer accustoms himself to testing everything he handles, the sooner he will be master of the situation. If this work is ignored, and he follows only well-worn tracks, and the information of "material men," he will be in "hot water" most of the time.

In specifying materials, one maxim should always govern: *Never specify a quality which you cannot demonstrate exists; or forbid a quality or ingredient you cannot detect.* For instance, if you are not prepared to have a chemical analysis made of the Portland cement, do not say anything about sulphur or magnesia; clauses of this kind may sound well, but they may also cause you trouble, if later you cannot tell anything about the composition of the material. If you rely on the analyses as made by the manufacturers, you can depend on it that you will never find a cement with a harmful percentage of either.

* See later discussion of "Studies in Materials."

The problems relative to materials will be discussed under the following headings—*sand, cement, lumber, and roof materials.* In addition to the work along the lines laid out, the powers of observation should be so cultivated that, in the daily routine, wherever work is encountered, the eye will be ever ready to detect any phase of development in material.

SAND

Essential Qualities. Sand will be considered only in connection with cement (Portland cement).* The province of sand with cement is, on a small scale, similar to that of brick in masonry. The cement acts in the same capacity as the mortar surrounding the brick. If a brick could be made the size of the complete wall there would be no need for mortar, but as it cannot, mortar is required to fill thoroughly all spaces between the bricks and to adhere to each tenaciously so as to form one solid mass. If on the sides of the brick should be placed thin layers of soft clay, the bond would be broken, inasmuch as the clay would not cling tenaciously to the brick and would prevent contact between the brick and the mortar; therefore, to obtain a good brick wall, each brick must be clean and free from a coating of foreign material, so that contact with the mortar will be complete.

To return to sand—in the same way each particle must be entirely separate from any other, and must be free from foreign

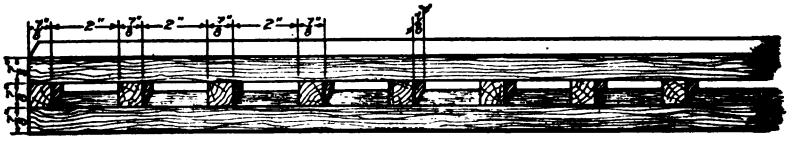


Fig. 1. Molds for Making Sand-Testing Bricks.

coatings which would prevent its contact with the cement or would cause the particles to cling together so that a thorough coating of each particle with cement would be impossible. The usual requirements for sand in cement work is that it shall be "clean, coarse, and sharp." Rarely should more than three volumes of sand be

* See discussion of "Cement."

used to one volume of cement, but for our building we must be more economical. We find in the pits on the site a soft, fine sand, which, while it separates well, resembles ground clay when rubbed between the fingers. Before throwing it out as useless and paying a round price for sand hauled in, let us see what can be done with it.

Tests. The sand may be tested by using the material to make sample cement bricks.

Make frames of wood screwed together which will provide 32 molds for bricks 2 inches long, with 7/8-inch section, Fig. 1, using two long strips 7/8-inch square divided by 7/8-inch strips so as to leave 2 inches clear between each, all to be oiled. Obtain some clean, coarse, sharp sand for comparison, and also some of the fine soft sand from the site; carefully mix (dry) sand of both kinds with cement in four different proportions—first in the proportion of 3 parts sand to 1 cement, then of 4 parts sand to 1 cement, then of 5 parts sand to 1 cement, and lastly of 6 parts sand to 1 cement—eight batches in all. Make enough of each batch to mold four bricks. Mix each batch with the greatest thoroughness, in order that every side of every particle of sand shall become coated; then add just enough water to dampen thoroughly, and crowd the mixtures into the molds (which should be laid on a smooth plank, for bottom), compressing each as much as possible. If water appears on top, it will indicate that too much has been used in mixing. Place on each brick an identifying mark, such as

No. 1 3-1, standard sand	No. 5 3-1, common sand
No. 2 4-1, standard sand	No. 6 4-1, common sand
No. 3 5-1, standard sand	No. 7 5-1, common sand
No. 4 6-1, standard sand	No. 8 6-1, common sand

Cover with a damp cloth to prevent evaporation; and after one day draw out the screws holding the forms, and keep the bricks moist for two weeks—either covered with a wet cloth or immersed in water.

At the end of that time the test of the bricks for crushing strength should be made. Obtain first two good, smooth planks about 3 feet long by 1 foot wide, then go to a neighboring foundry, and get permission to use their scales and a few hundred pounds of pig iron; lay down one plank on a perfectly level bed, and on

it place the No. 8 bricks on their sides, Fig. 2. In order to get an even bearing it is well to put below and above the cement bricks one layer of soft building paper; on top place the second plank with great care, seeing that it has a firm, even bearing at each of the four bricks. Now carefully lay pig iron on the upper plank, beginning at the middle, and loading toward each end, never filling one side before the other or with a much heavier load. Carefully watch the bricks; note when they crack, and when they crumble; weigh the pig iron, and note the results.

Test each of the remaining seven sets of bricks in the same way.

It is safe for ordinary dwellings to select the cheapest materials and mixture which will carry under such conditions 500 pounds

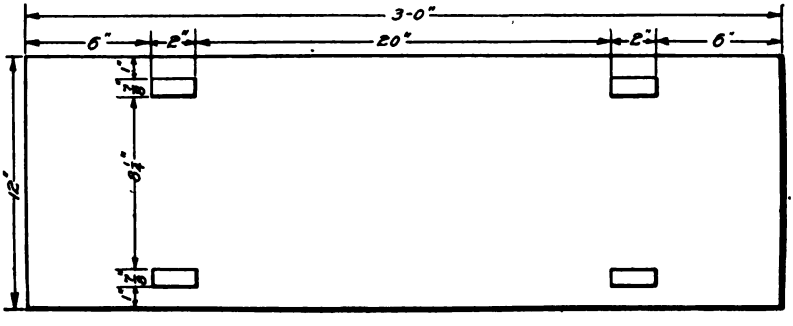


Fig. 2. Planks with Bricks Located for Crushing Test.

of iron. For example, it is supposed that No. 3 sample, made up of 5 parts standard coarse sand to 1 part cement, carries the same load as No. 6, made of 4 parts sand from the site to 1 part cement. If it costs $1.50 for one cubic yard of coarse sand, and $0.50 a yard to haul the sand away from the excavation, the coarse sand costs us for use $2.00 a cubic yard or $0.074 cents a cubic foot. With cement at $2.00 a barrel, the total cost would be as follows:

Cost of 5 cu. ft. sand	$0.37
Cost of 1 cu. ft. cement	0.67
Cost of 5 cu. ft. mortar*	$1.04
∴Cost of 1 cu. ft. mortar	$0.20⅘

* When sand and cement are mixed in proper proportions, the bulk of the mixture is not (theoretically) greater than the bulk of the sand, as the cement only fills the voids or spaces between the particles of sand, just as there can be poured into a full measure of shot 20 per cent of water without overflowing the measure.

Using sand from the site in mixture No. 6 (4 parts sand to 1 cement), we have the cost per cubic foot as follows:

Cost of 4 cu. ft. sand	$0.00
Cost of 1 cu. ft. cement	$0.67
Cost of 4 cu. ft. mortar	$0.67
∴Cost of 1 cu. ft. mortar	$0.16¾

It will thus be seen that it is cheaper to use the 4 to 1 mixture and the poorer sand from the site, than to haul the sand away, bring in other sand, and use less cement. If, on the other hand, it is found that it will require No. 5 to equal No. 3, it will be cheaper to haul away the excavated sand and haul in good sand.

Before breaking the bricks, they should be very carefully examined as to texture and firmness. Scratching with the finger nail will show the general quality to the student after a short experience; experiment with weights is therefore unnecessary after the student has become familiar with the appearance of good mortar.

After the bricks are broken, examine the fractures, and observe with a glass how well the spaces between the particles of sand are filled. Generally the results will be about as follows:

No. 1 will show much greater strength than No. 5
No. 2 will not be of much greater strength than No. 6
No. 3 will perhaps break under less weight than No. 7
No. 4 will break and crumble long before No. 8

The reasons for these differences are readily detected under a glass. The imported coarse sand requires much more cement to fill the spaces. In No. 1 they are all filled; while in No. 4 there are large voids, which do not occur to such an extent in Nos. 7 and 8; the sand being finer allows smaller voids. *Observe* that the increase in the number of voids or small holes in the mass weakens the mixture.

Now try one other experiment. Get two forms from which 4-inch cubes can be made. Make a mixture of, say, 4 parts fine sand to 1 part cement; mix half of it with a large amount of water, as is usually done in ordinary work, and from this form a 4-inch cube. Mix the other half with just enough water to change throughout the color of the mass, and from this make another 4-inch cube. Crowd the mixtures into the form, both cubes to be compressed as

much as possible; set the cubes aside, covered with a wet cloth for a week; then split with a cold chisel, and observe. The interior make-up of that mixed with a larger amount of water is full of voids; that mixed with little water is compact.

The question of sand is treated, as later the question of roofs will be, with a great deal of "home-made" detail, not only to get at the question of sand and roofs, but to illustrate how, with materials that are always at hand, results of great practical value may be obtained.

CEMENT

There is probably no other building material of which so much has been written as cement within the last ten years; and there will be no attempt here to discuss the question except from an extremely practical standpoint. All things considered, Portland cement at $2.00 a barrel net is the most economical material for general masonry. Lime is much cheaper, but of very doubtful value as generally made. The English, Scotch, and French use lime with great success; but it is always slaked in pits for at least three months prior to use, and is treated and worked so as to make it valuable for mortar, while in this country the lime undergoes such crude treatment that it cannot be considered a material suitable for good work. Therefore lime in any form will not be further considered for masonry work.

Classes of Product. There are now three classes of Portland cement on sale in this country. By far the largest class is that ground from an artificial clinker. Second are those known as slag cements, ground largely from furnace slag. While in much of the product of the second class the sulphur has been so far extracted as to make it identical in chemical analysis with the cement of the first class, and of great value in general masonry, it is wiser to avoid the use of slag cement where surfaces are exposed to wear, as in sidewalks, steps, etc. Unless the work is of minor importance slag cement should not be used unless such chemical tests (independent of tests made by the manufacturers) can be obtained as will show that the sulphur therein is below 2 per cent.

The third class is one imported from Belgium under various brands carrying English names, such as "Eagle", "Star", etc., the

packages showing, however, the place of manufacture. These cements are generally coarse and of low grade—possibly the factory's second grade, on which the manufacturer does not care to put his regular brand.

English cement is practically out of the market.

A few brands of German remain, like the "Dykerhoff", which commands a high price and for which there is a limited demand from users who believe there is no other from which equally good results can be obtained. For our purposes, however, the second and third classes need not be considered; the range in the first is wide, and little if anything is gained in price in using either of the others.

Tests. On important work, tests should be made to determine the fineness of grinding, specific gravity, time of initial and final set, soundness, the proportion of silica to lime, and the amount of sulphur and magnesia. Tests are also made of tensile strength; but since this is a quality never required of cement, and this test only indirectly bears on other necessary qualities, and since the presence of matter which is likely to cause final disintegration, tends often—in the early stages of use—to increase the tensile strength, such tests should be in no way relied on.

In this paper, only three tests which it is possible for the student to make with appliances easily obtained, will be considered.

Fineness. To test for fineness, what is known as a 100-mesh sieve—that is, a sieve with 100 spaces to an inch—should be obtained. Any first-class hardware store can furnish the wire either from stock or on order, and a home-made sieve can be constructed. A small quantity of cement should be weighed and most carefully sifted; 90 per cent of the material should pass through the sieve. By referring to statements relative to cement, made under "Sand", the student will understand that extreme fineness is required in order that the cement may fit in and completely fill any voids which may exist between the particles of sand.

Initial Set. The time for the initial set is determined approximately as follows:

Mix a small amount of neat cement (clear cement without sand) with water, to the consistency of stiff mortar; observe the time it takes to set hard enough to prevent an indentation when on it is

placed a wire about 6 inches long and of $\frac{1}{12}$-inch diameter loaded with a ¼-pound ball on top. The time should not be less than 30 minutes.

It is unwise to use cement which sets at once or in so short a time that it can hardly be placed before the set occurs. Cement fresh from the works often takes its first set quickly; but after it has attained an age of two or three months it improves in this respect. Therefore, never specify "fresh cement," as cement should not be used within three months from the date of its manufacture.

It should be noted that the setting quality of cement consists in the *permanent* union of water with the cement. The setting of cement mortar is often referred to as the "drying out"; as a matter of fact, the water necessary for mixing the mortar never leaves it unless driven off by extreme heat. This may be proved by a simple experiment. Take a tin can with tight cover; weigh out five pounds of dry cement; mix with it enough water to wet it; pack it in the can and thoroughly compress it. If water rises to the top—indicating that too much has been added—pour it off; put on the cover tight, and weigh the whole, to determine the amount of water added; then set it away for two weeks. At the end of the time, open the can and put it in a warm, dry place for a few days so that the cement may be thoroughly dry, then weigh. It will be found that the weight is that of the original cement plus the water added, which still remains in the mass. Subject the cement to extreme heat, and it will be found that the water is thrown off, the cement becomes fine again, and its weight corresponds with that originally used.

Soundness. This is one of the most important physical tests, for it indicates whether there probably exist elements which will eventually disintegrate the mass. Test pats must be made and their action carefully observed; if warping, cracking, or blotches appear, the material should not be used. Form on small pieces of clean glass four pats of cement mixed with only so much water as will turn the color of the cement. The pats should be about 3 inches in diameter and ½ inch thick in the center, tapering to the edge, which should be as thin as possible. After the pats have been for a day under a damp cloth, put two of them in water for a week,

and leave two in air, then examine for the symptoms referred to above.

Should it be possible to test the material chemically, the following points should be observed:

The amount of lime should be slightly over three times that of the silica. Thus, if there is 20 per cent silica, the lime should run from 60 to 62 per cent. The silica should not fall below 19 per cent, or rise above 22 per cent, and this is about the range of good cements on the market.

More than 2 per cent of sulphur should never be allowed. The reason for this is that the setting of cement is a process in which the various materials combined unite chemically to form one solid mass. Sulphur in its various forms is an ingredient which does not work in harmony with the other materials; while it does not at once prevent the satisfactory combination and setting of the other materials, yet under conditions that are very likely to prevail it sets up a chemical action tending to disintegrate the mass in time.

Magnesia can generally be considered an ingredient which has no value either as sand or cement, being what is known as "inert" material. While 4 per cent may not injure masonry, wearing surfaces should not have over 3 per cent.

The manufacturers of Portland cement have tried to eliminate both of these ingredients—but so far without success at a cost which would make it possible to sell the cement at a profit.

The specific gravity should not fall below 3.10, as a low specific gravity indicates poor burning of the clinker.

These later tests, however, are delicate laboratory operations, and only experienced chemists are capable of getting satisfactory results.

Non-staining Cements. There is a very general prejudice against the use of the ordinary Portland cement for setting limestone, sandstone, and marble, the theory being that the moisture from the mixture, in getting away, travels through the stone, carrying with it certain staining matter, which is either deposited on the surface or unites chemically with ingredients in the air to stain the face. For this reason there have come to be used certain mate-

rials of much less structural value than the Portland cement. These are called *non-staining* cements, and are sold at a high price.

There are also on the market many materials intended to be put on the back of stone, which, the manufacturers assert, will prevent the passage of moisture and staining matter. While it can easily be demonstrated that water containing cement running over the face of soft stones does leave distinct traces, it is a different thing to show that such stone or marble can be stained by materials in the joints or on the back. It is well, before any amount of money is spent, to experiment in producing the stain on the stone used with the ordinary cement.

This may be done by filling a small box with soft mortar, and placing therein a piece of stone or marble, so laid that the top surface is $\frac{1}{8}$ inch above the mortar. Then tack a piece of waterproof paper to the box sides, and cut a hole somewhat smaller than the upper face of the stone or marble sample used, using weights to bring the inner edge of the paper to the stone so that practically no moisture can pass except through the sample and off from the exposed surface. The results of the so-called staining qualities of ordinary cement can in this way be determined.

LUMBER FOR CONSTRUCTION AND FINISH

Local conditions affect very much the grading of lumber. While the great lumber interests formulate and publish schedules of grades, the user cannot, from their designations and descriptions of grades alone, make an economical selection. The designations "first" or "best quality," "without imperfections," etc., inserted in specifications to describe the quality desired, tend to make trouble for everyone concerned on account of the various meanings put on these terms.

Some markets are well supplied with good spruce framing lumber, while an adjoining section will have no spruce but will have good rough pine or hemlock. The same differences will be found relative to finishing lumber. The student should visit each lumber yard, look over the stocks, find materials in that market and how they are graded; he is then prepared to state in the specifications just what imperfections can be allowed in framing timber, boards, or finishing lumber, but he must always bear in

mind that there is no material in existence which is free from imperfections. By observing the defects and stating clearly what will be allowed and what will not, he can avoid very many unpleasant misunderstandings, with the owner especially, and also with the builder.

Lumber which has the largest number of good qualities is the most expensive; therefore, for each portion of the work, only that material should be required which has the particular qualities required for that particular place.

Since in the case of lumber the questions of grade, quality, etc., can be determined by observation rather than by such experiments as are indicated for cement or sand, these matters will not be further treated here; but in the following specifications, there will be illustrated what consideration should be given generally to lumber grades, quality, and finishes.

ROOFING MATERIAL

Value of "Thinking in Construction." In the previous examples or problems attention has been given to putting the student in line of *thinking in materials.* In this section consideration will be given to the combination of materials in a roof covering, partly because a good roof is one of the prime necessities of a successful structure, and also because, in a brief study of one type of roof of which a model can easily be constructed, the elements of how *to think in construction* within the province of the specification can be clearly illustrated.

The particular covering here considered is canvas. Undoubtedly each student is familiar with the use of canvas for boats—from steamships, sailing vessels, etc., the decks of which are covered with canvas—down to the small duck boat completely constructed of this material; but it is possible that few have ever considered the various steps necessary to make it available for water and wear-resisting uses.

Study of Canvas as Roof Covering. Canvas, in its natural condition, is far from waterproof, and is one of the materials most easily and quickly destroyed by mildew. Its one original desirable quality is its extreme strength and toughness. Therefore there must be incorporated with this toughness the properties of resisting

the passage of water and the ravages of decay. To prove to yourself how tough a material canvas is, take a good sample of 10-ounce duck; put it on a board, and strike a dozen times in one place; take it up, rub it in the hands, and observe how little damage has been done to the texture. The following experiment will show how the other essential qualities are added:

Build up of 7/8-inch matched flooring, dressed on the upper side, a board about 3 feet square, putting 2- by 4-inch cleats on the underside. These cleats represent the rafters, the 7/8-inch stuff, the roof boards. Obtain from different stores samples of 10-ounce duck, and mark each for identification, making a schedule in which the price of each is noted. Cut all samples to exactly the same size; and, after drying thoroughly to drive off all moisture, have them weighed by a druggist on very accurate scales, noting on the schedule the weight of each piece. Soak and wash each thoroughly, rubbing so as to remove all size or filling *soluble in water*. After the samples are thoroughly dry, have each carefully weighed again, and note the weights on the schedule. From this schedule can easily be determined which is the best material for the money. It may be found, for example, after soaking out all soluble matter, that the canvas which costs 18 cents a yard is considerably cheaper than that costing 17 cents.

A choice having been made, buy a yard; and, when thoroughly dry, secure it to the boards prepared, using ordinary tacks, about 5/8-inch long, spaced one inch apart; stretch the cloth as much as possible so that it will be tight and flat. Wet it thoroughly and *observe* that wetting has a *tendency* to shrink it; but, as it cannot shrink because it is securely nailed to the board, each thread is drawn very tight and made smaller. A close examination will show that the spaces between the threads are increased and that water runs through as through a sieve. While the canvas is in this condition, put on a good coat of white lead and oil paint (this is about the only material which should be painted wet), and *observe* that a large amount of paint is taken up; in fact, the paint goes through the openings between the threads, reaching and covering the underside of the cotton. The water does not unite with the paint, and passes off before the paint dries, allowing the threads to swell into the soft paint, so that when the paint is dry the fabric

is practically imbedded in it, with less on the upper surface than anywhere else. Two more coats on top are necessary. This treatment protects the canvas from mildew and makes it waterproof; the original fabric furnishes the strength.

After the paint is dry, subject the sample to the harshest of treatment. Grind with the heel, drop bricks, etc., to see just how much it will resist; if not successful in making a hole, use a hatchet, patching the hole so made by tacking over it a piece of duck of sufficient size to cover it; wetting it, and painting it, etc., as before. When dry, place the boards level, nail down 1-inch strips around the edge, laid in white lead, and cover with one inch of water. Let this stand for forty-eight hours. Now cut up the duck, and see if any leaks exist; if so, carefully examine the covering to determine exactly the cause. Next, roll the duck loosely, and put away for two weeks in a dark, damp place, and then examine for mildew.

It is not the intention in using this illustration merely to explain how a canvas roof is made, but to set the student to thinking about roofs. A shingle roof, or a tar-and-gravel roof, or a slate roof, differs only in the manner in which it accomplishes the same ends. All other types of roofing should be observed and studied along similar lines, so that the proper material will be used in each of the different varieties of buildings.

ELECTRIC WIRING

Special Nature of Wiring Specifications. The item of electric wiring, while entirely within the province of the architect to lay out, is of such a mechanical nature that it is rarely advisable to include it in the general specification. Few general rules outside of a set adopted by the National Board of Fire Underwriters—called the "National Electric Code"—can be formulated.

The arrangement, location, and sizes of wires are problems involving delicate adjustment in order to obviate danger from fire, to prevent loss of power, and to obtain a perfectly satisfactory service at all points under the maximum load, and yet keep the amount of material down so as to avoid unnecessary expense.

Expensive instruments are necessary for the testing of the system when complete, and a considerable experience is needed

even for stating in a specification what tests are to be applied in each specific case. Therefore it is not deemed best to discuss the matter further here, except to state that for work such as that under consideration, the services of an engineer in the employ of the electric light company which is to furnish the energy can generally be obtained to lay out the system and to test the completed work.

OUTLINE SPECIFICATIONS

In studying the following outline specification, it is suggested that many trade papers and the general magazines advertise appliances used in building, and that a postal card request to the advertisers will bring very useful information about the product advertised. Especially is this true as regards cement, concrete, stone, brick, paints, varnishes, plastering material, plumbing goods, and heating goods.

Catalogues of the last two are particularly easy to obtain and are well worth studying. If the student finds himself especially impressed with any one system or brand of goods, he should make it a point to learn about other materials or systems which are used for the same purpose, until he finds some which, he is satisfied, are equally good. The man who has only one material he can use, or one way of accomplishing a certain object, is sure to be either deficient in information or unduly influenced; there is no one material, or one way of doing anything that is best in all respects.

The student should also have a copy of some of the many handbooks of general information relative to materials. Of these, probably Trautwine will be found the most useful; for, while it is not so popular as some, it is a high authority, and in it will be found notes on every variety of material and construction.

SPECIFICATIONS

FOR A RESIDENCE BUILDING TO BE ERECTED FOR

~~JOHN DOE~~

~~THE~~ CORNER OF A AVENUE AND B STREET, CHICAGO, ILLINOIS

Richard ~~Roe~~, ~~Architect~~

GENERAL CONDITIONS

Contract Drawings. The drawings which will with this specification form the basis of an agreement for the erection and completion of a residence for John Doe, to be erected at the corner of A Avenue and B Street, are numbered 1, 2, 3, 4, 5, 6, 7, to a scale of ¼ inch to the foot; and details, 20, 21, 22, 23, to a scale of 1½ inches. All materials and work necessary to complete the structure indicated, are to be furnished and done by the Contractor.

It is the intention that the general scheme for the work shall be illustrated by the drawings, on which all dimensions and sizes are given. When features or details are evidently of a similar nature to those already shown, they will not be carried out in detail; but in all such cases the Contractor will complete the work in accordance with the evident intent of the drawings.

The materials are in general designated; and when the drawings are competent to show fully what is required, it will not be within the province of the specification, or details to be prepared later, to make further reference thereto.

Detail Drawings. Full-sized details and models will be furnished as the work progresses, and no work requiring them is to be done before their delivery. In their preparation, minor modifications may be made which do not materially affect the cost of execution. The drawings will be delivered to the Contractor within the following periods after the award of the contract:

For construction of exterior walls, cornice, roof, or material framing	6 weeks
For interior finish	4 months
For carving on material in place	6 months

Specifications. It is the intention that this specification shall cover those points with regard to materials which the drawings are not competent to cover; and the fact that certain items are indicated on the drawings, and not mentioned herein, shall not relieve the Contractor from furnishing them. It is the intention that the drawings and this specification shall so co-operate that all matters in connection with the proposed structure necessary for making accurate estimates for the completion of the building, shall be fully set forth. There are, however, certain operations and materials obviously necessary for the construction; and unless these are of unusual nature, no mention thereof will be made, but such fact shall not relieve the Contractor from his obligation to provide for all such items.

Changes in Plans. No alterations shall be made involving change in cost, unless ordered by the Architect in writing. The

written order must set forth fully the nature and extent of the change, and the terms and conditions under which it is to be made, and to it the assent of both Owner and Contractor is to be attached.

The ~~Architect~~ shall, during the progress of the work, give oral directions relative thereto; but such directions shall not be considered as authorizing changes.

Acceptance and Rejection of Materials. The decision of the ~~Architect~~ shall be final relative to the work and materials furnished, and the materials rejected are to be removed promptly from the site. It shall be understood, however, that every item furnished in place in the building which is covered by a payment, is considered as accepted, and shall not be later rejected unless defects develop which were not visible prior to the payment; and when, for such cause, material is rejected, the entire expense incident to replacing the material is to be borne by the Contractor.

Responsibility of Contractor. The Contractor is to be entirely responsible for producing the finished work in place; and in carrying it out, he is to furnish all tools and temporary appliances to accomplish the contract requirements; he must also supply heat, so that after the first plaster coat is begun no part of the building shall be allowed to have a temperature lower than 40 degrees Fahrenheit. If plastering is done in hot, dry weather, Contractor is to protect the building with such temporary closures as will prevent injury from too rapid evaporation. He is to be responsible for the protection, not only of all material delivered on the site, but also of all materials in place, until the acceptance of the building as evidenced by the final payment on the contract and the delivery of the structure to the Owner. As this responsibility extends to loss by fire, he is to keep the building fully insured in stock insurance companies, the loss, if any, payable to the Owner as his interest may appear. The total amount of such insurance shall never be less than a sum 20 per cent higher than the total amount of the payments made; and prior to each payment, the Contractor shall deliver to the Owner such policies.

The Contractor shall, if required by the Owner four days prior to the time any payment is due, produce evidence satisfactory to the Owner that such settlements have been made as will clear the premises from the liability of liens on account of either labor or materials furnished; and in case the Contractor fails to produce such evidence, the Owner is not under any obligations to make the payment until his demand is complied with. If the demand is not made by the Owner four days prior to the day any payment is due, the Contractor shall not be obliged to furnish evidence for the payment then coming due; but the right to demand the evidence before any subsequent payment is made, will continue to exist, so

that the Owner may demand such evidence prior to any future payment.

Compliance with City Laws. The Contractor, without the intervention of ~~either~~ Owner ~~or Architect,~~ is to comply with all city ordinances for the regulation of building on private property and the temporary use of highways beyond the building lines.

Employer's Liability Insurance. Should any person, whether employed by the Contractor or not, or any property, be injured in any of the operations in connection with the building or through the carelessness of the Contractor or any of his employes, the Contractor is to be responsible therefor; and he must, consequently, carry at all times employer's liability insurance which will cover up to $5,000 the damage to any one person, either of the public or of those in his employ.

Ladders and Scaffolds. The Contractor is to maintain at all times such ladders and scaffolding as will afford the Owner ~~or Architect~~ access to all portions of the work.

Samples of Materials. As soon as possible after the award of the contract, the Contractor is to deliver on the site samples of all materials required in connection therewith. Since the samples are to indicate the range in the materials he proposes to use, they should represent both the poorest quality and the best in each class, the understanding being that the material furnished is to run between the two, so that the average of the material will be practically the average between the two samples.

The Architect shall pass on these samples; and after acceptance by him, they are to be kept for guidance in passing on the material when delivered. If any of the samples, in the opinion of the Architect, are not in accord with the contract requirements, he shall reject such in writing, setting forth fully his reasons, and the Contractor is to furnish additional samples in lieu of those rejected, until materials suitable, in the judgment of the Architect, are submitted. In executing the work, the poorer materials are to be placed in the minor portions of the work, as selected by the Architect.

Contractor's Foreman. The Contractor is to have a representative, fully empowered to act in all cases for him, on the site whenever any work is in progress or any material is being delivered; and ~~neither~~ the Owner ~~nor the Architect~~ shall give to anyone, except such representative, any directions or instructions. Should such representative not give proper attention to such directions or instructions, such neglect will be sufficient cause for refusal on the part of the Owner to make further payments until the settlement of the questions involved.

Architect. The Architect is the technical adviser for the Owner, and shall have the general direction and oversight of the building operations, with the right, conceded by both Owner and Contractor, to accept or reject finally materials or workmanship, to decide the amount due at each payment period, and to determine when the Contractor has complied with the conditions of his agreement.

He is not to be responsible for such questions as those relating to liability for liens, or for such other matters of business detail as do not require the technical training for architectural practice.

As the Architect must depend on the clear requirements of the drawings and specifications for his authority in exercising his duties, it is desirable that all questions which may arise be fully settled therein, so far as practicable, before the submission of bids. Therefore all parties who propose to submit bids should, in writing, call attention to any points which in their judgment are not fully explained by the drawings and specifications, at least six days before the time set for receipt of proposals; and such questions, with the replies thereto, will be forwarded to each prospective bidder. The failure of any bidder to ask for such supplementary information will be construed, after the award of the contract, as barring him from demurring from any ruling which in the opinion of the Architect is justified by the contract requirements. In any questions of a technical character which may arise between the Owner and Contractor, the Owner shall be governed by the decision of the Architect.

Payments. Before beginning the work, the Contractor, if he so desires, can prepare for the ~~Architect~~ Owner a statement showing the order in which he will proceed with the construction of the building; and a schedule of the quantities of all items entering into the work, with the value of each in place—the total of such values to be the contract price. If, in the judgment of the Architect, this schedule is perfectly fair, it shall be adopted as a basis of the monthly estimate of the value of the work satisfactorily in place; and on the third day of each month, the Owner shall pay on the contract price 90 per cent of the value of the materials satisfactorily in place on the first, as determined by the schedule; but in these estimates, no account shall, under any circumstances, be taken of the value of materials not finally incorporated in the building.

If, however, the Contractor does not elect to prepare such a schedule, or prepares a schedule evidently not fair to the Owner, then the Owner shall pay to the Contractor on the third of each month 90 per cent of the value of the materials satisfactorily in place, as determined by the Architect's estimate; and in determining the value, the Architect is to be governed by the total contract

price, so that at all times there will be reserved by the Owner sufficient funds to complete the building, in case of default on the part of the Contractor, at usual market rates, and, in addition, 10 per cent.

Time of Completion. The time limit for the completion of the work shall be (~~nine~~) months from the date of award of contract; and it shall be a condition of the contract, that there will be deducted from the final payment the sum of fifteen dollars ($15.00) as liquidated damages for each day's delay after the expiration of such period, until the final acceptance of the work by the Architect and its delivery to the Owner.

Protection of Lot. Put a tight board fence 5 feet high, with three 2- by 4-inch rails, and with 4- by 4-inch posts set 6 feet on centers, which will protect adjoining property from encroachment during building operations.

On the street side, and in front of the spot to be occupied by the building on the avenue, enclose such portion of the roadway as is permitted by the city building ordinance to be used in building operations; build also such fence, and place such walks as are required by such ordinance.

On the site is one oak tree, and in the street two elm trees. These are to be protected by tree boxes of 2-inch plank and 2- by 4-inch cleats, with such holes cut on sides as will permit a full circulation of air about the trunk; under no circumstances are any guy ropes to be secured to, or allowed to interfere with, any portion of the trees.

There will be no attempt to save any of the sod or shrubs now on the site, and the Contractor will be allowed all the space for piling material, etc.

The protection by the Contractor, of trees, sidewalk, curb, adjoining property, etc., as required hereinafter, shall not relieve the Contractor from responsibility for any injury which may occur to such protected items on account of the building operations.

EXCAVATION

Disposition of Excavated Materials. Four test pits have been dug to a point one foot below the bottom of all footings; and bidders should visit the site and examine the conditions. The black soil which constitutes the top stratum is all to be piled on the lot, wherever the Contractor desires, so long as it is not against the oak tree. Below the black soil is a stratum of sand which is satisfactory for concrete and cement mortar; below this is coarse gravel which may be used for concrete, provided all stones which will not pass through a 2-inch ring are cracked to such size. Any other

material to be taken from the excavation is worthless, and must be hauled away.

The excavation is to be carried on so that different strata will be kept in separate piles. Any materials mixed so as to make it undesirable in the opinion of the Architect to use them for the purposes above designated, are to be hauled away.

Shoring. The curbstone in place is to be protected by sheet piling driven down just back of the inside of curb line so that there will be no settlement or shifting before the supporting wall is completed.

The other sides of the excavations are to be sloped enough to prevent caving.

The excavation is not to go below the party wall of the adjoining building.

All excavations for footings must be complete before any footings are placed.

Backfilling. After all foundation walls are completed and thoroughly set, backfilling is to be done with sand or gravel.

Sewer and Water Connections. The sewer and water have already been brought to the site. The sewer terminates at a brick manhole, 3 feet 6 inches inside diameter, with iron cover, at grade about 5 feet from the side line of the building; and temporary connections with this manhole are to be made, so that there shall be at no time any standing water in the excavation, should it develop that the gravel is a water-bearing stratum.

The water connections will be encountered, in making the wall at the curb line, about 4 feet below grade.

MASONRY

Materials Required

Cement. All cement is to be Portland cement, of such fineness that 90 per cent will pass through a 100-mesh sieve. The initial set shall be in not less than 30 minutes; and pats of neat cement, about 3 inches in diameter and ½ inch thick in center, worked off to a thin edge, which has been exposed in air or immersed in water for seven days, after the cement has set sufficiently not to be disintegrated by water, shall show no discoloration, warping, checks, or signs of disintegration.

Sand. The sand shown to be on the site by the test pits is of sufficiently good quality for all masonry mortar except wearing surface of pavements, steps, etc. Should there not be enough thus obtained, that brought in must be as clean and sharp as that found in excavating.

The sand for all wearing surfaces, such as walks, steps, and

cellar and area floors, down for at least ½ inch, is to be crushed granite, ranging from the finest material to that which will pass a 30-mesh sieve.

Broken Stone. The gravel stratum may be used for concrete aggregate, provided the sand and all stone too large to pass a 2-inch ring are screened out. The sand may be used with other sand on the site, and the stone screened out be broken to size required; the other material needed shall be equal to that obtained on the site, and the Contractor shall not dig holes below the finished grade lines to obtain material.

Brick. *Common Brick.* All *common* brick are to be run of the kiln, excluding salmon brick, which will take up during one hour's immersion in water as much as 18 per cent of their weight in water. As delivered, the hardest are to be kept in piles for use in backing exterior walls and flues; the softer are to be put in interior walls.

Facing Brick. All *facing* brick are to be of light color and rough face texture; evenness of tone or burning will not be required; and the light and dark tones will be laid together, with no attempt to keep the same tones together; but no brick shall be allowed which is soft enough to absorb over 12 per cent of its weight in water. The facing brick are to have full square edges, free from chipped corners.

Granite. The exterior wall below water table, and the front steps and buttresses, are to be of granite. All granite is to be of light color, free from black knots, and is to be finished 4-cut work. The joints are to be ⅜ inch wide, and tooled back full for 1 inch from exterior surface. The stones may be as thin as economical dressing will permit.

Soft Stone. From water table up to the line of the second-story window sills, all stone required is to be a light limestone or sandstone with a 4-bat-to-the-inch finish (consisting of 4 concave grooves to each inch, made either by hand or by machine) for all vertical surfaces. All other surfaces shall be rubbed. The stone must be of an even texture, free from seams or streaks. Should any material used show in a rubbed block any grain from which the natural bed can be determined, it is to be set so that it will rest on its natural bed; but if the stone is of such character as to show no such indications, it will be immaterial whether or not it rests on its natural bed.

The ashlar may be as thin as 4 inches, except where reveals or corners occur. At reveals the heads are to be the full depth; and no vertical joint in the face of the wall is to be nearer the reveal than 1 foot, while all caps and sills are to be the full depth.

Terra Cotta. *Structural.* The interior faces of all exterior

brick walls are to be furred with 2-inch porous terra cotta of such quality that a nail can be driven therein without splitting, and firmly held.

All flues are to be lined with hard-burned non-porous flue linings, at least ¾ inch thick.

Ornamental. All ornamental terra cotta for cornice and balustrade is to have a color similar to the lighter tones of brick, with a combed surface forming about 6 ribs to one inch. The terra cotta is to be hard-burned, with capacity to absorb not over 4 per cent of its weight of water after immersion for one hour. All approximately horizontal surfaces are to be made rough, to key the cement coat which it is proposed to put above. The finished pieces are to be straight and unwarped, and in lengths never less than 2 feet 10 inches for continuous members; in projecting members, all vertical joints must occur over bearings. All members with less than 2-feet face must be in one piece. The Contractor must furnish shop drawings for approval of jointing only; no outlines are to be modified thereby, and such changes in the jointings may be made, within the lines previously laid down, as in the judgment of the Architect will better the construction or appearance of the work.

Masonry Construction

Concrete Work. The concrete work of all footings and exterior foundation walls below grade, shall be composed of 1 part Portland cement, 4 parts sand, and 7 parts screened gravel or broken stone. In order to make these proportions efficient, it will be necessary, in mixing and applying the materials, to use great care. The Contractor, under direction of the Architect, shall construct a cube of the mixture about 18 inches square, to show its possibilities when carefully manipulated; this standard shall be the one by which the work will be judged, and any portion of the concrete work which falls below this standard will be condemned. The sand and cement must first be thoroughly mixed dry, turning it over at least four times if no machine is employed, so that no uncolored particles of sand can be detected; after which, just enough water is to be added to dampen the mass thoroughly. The aggregate is then to be mixed in, wet.

Walls. It will be necessary to place plank forms for all footings and walls; the concrete is to be put in such forms, and thoroughly rammed. A smooth surface like a spade is to be forced down, just inside the planking, to force the aggregate back from both faces of the wall until clear motar only shows. The walls of each portion are to be carried up the full height rapidly, and the planking to be so arranged that it can be removed from any part within two days after the placing of the concrete. Both faces of

the wall are to be finished smooth with a trowel, the surface being so compressed as to make it proof against ground moisture.

Basement Floor. After the lining of the first floor has been laid, the basement floor is to be put in. On the base of concrete 3 inches thick, composed as for footings, put, before it has set, a wearing surface ½ inch thick, composed of 1 part cement to 3 parts crushed granite, troweled to a smooth, level surface.

Beams and Slabs over Sidewalk Cellar. Reinforced concrete beams and slabs over the sidewalk coal cellar, are to be composed of 1 part Portland cement, 3 parts sand, and 5 parts gravel or broken stone which will pass through a ¾-inch ring. This is to be tamped in the forms and around the reinforcing metal, to form a solid, compact mass. As the strength of this slab is dependent principally on the care in mixing the material and in placing it, it must be tested three weeks after it is set, by placing five layers of brick over the entire surface. If under this test it fails or cracks, it is to be removed and replaced at the Contractor's expense.

Sidewalk. After the completion of the building, a sidewalk, in all respects matching that now in place, is to be continued over the concrete slab, and the iron coalhole cover frame is to be built in so as to set flush with the surface.

Brickwork. *Rough Brick Walls and Chimneys.* The rough brick partition walls in basement, and all chimneys and the backing of all exterior walls, shall be laid and thoroughly imbedded in Portland cement mortar, 1 part cement to 4 parts sand; all brick are to be thoroughly drenched before being laid. In backing up stonework, the brick is to be so bonded that it can be brought up approximately level with the top of each stone course; there is to be placed in every horizontal stone joint a sheet of No. 24 expanded metal, extending to within 1 inch of the face of the stone and through the full thickness of the brick wall. This is to be free from rust, and at once imbedded in the mortar joints of stone and brick to form a reinforced concrete bond.

Every fifth course of rough brick is to be of headers.

Where rough brick walls will be exposed to view, the joints shall be trowel-pointed and all mortar kept off the face.

Chimney Openings in Wall and Fireplace. At the base of ash pits, set doors 8 inches by 12 inches.

At the base of chimney flues, set doors 6 inches by 8 inches.

In each fireplace hearth, there is to be a small cast-iron ash dump with cast-iron frames built in and anchored.

Terra cotta pipe thimbles are to be built in, 1 foot from the finished ceilings, as follows:

1—8-inch thimble in heater cellar
1—6-inch thimble in laundry
1—6-inch thimble in kitchen

Fireplaces. The fireplaces are to be built complete with firebrick backs and facings, all laid flat, as the chimney is constructed. Special-shaped firebrick, with ends molded so as to conform to the line of the facing and bevel of the jambs, are to be used at the angles between facing and jambs.

All brick below the flat arch are to be laid in fire clay with close joints; and in each joint a strip of No. 24 expanded metal is to be built, extending within ½ inch of the face of the brick and leaving at least 4 inches to build into the mortar joint of backing. In the throat, put cast-iron flue-stops, with dampers which can easily be closed from below.

The flat arches *above* are to be laid in Portland cement mortar, with No. 24 expanded metal extending through each joint to within ½ inch of exposed faces and sticking up 4 inches. When this is complete, a reinforced concrete beam is to be formed above, in which brick ties are to be imbedded, in addition to six strands of No. 8 twisted wire fencing.

The flue linings of hard terra cotta are to be set close; and any which are crooked or broken in handling shall be rejected.

Facing Brick. Facing brick shall be used for the visible surfaces of the exterior brick walls and chimneys. Each course will alternate headers and stretchers, and the facing and backing are to be carried up together and of such size brick that the headers of every fifth course will bond. The header of all other courses may be half-brick. The joints shall be approximately ½ inch thick, and trowel-pointed as the work is laid; all mortar must be kept off the face.

Over the windows, flat arches are to be formed, bonded, as required for the fireplaces, to the concrete beam formed back of the arch.

Setting of Granite and Soft Stone. The joints of all stonework are to be ⅜ inch thick, with expanded metal, as required above, the mortar to be of the same composition as for brick.

The Contractor will be responsible for any staining of the faces of the stone. He will be permitted to use such brand of cement as he may consider safe, provided in the tests it conforms to the requirements of Portland cement as stated under "Cement."

NOTE TO STUDENT. No. 1.—In order that the student may ascertain to what extent he is grasping the situation, he should, at this point, and before proceeding further with this specification, spend at least six hours on masonry work in progress in his vicinity, observing work which corresponds to that referred to in this outline specification. He should ask questions of such foremen or workmen as he is able to approach, regarding the details of construction and materials used. He should see the men who furnish the material, and obtain from them the prices, and also find out about different grades of the material.

Under no circumstances are notes to be taken. The student must absorb the information in such a way that he will *remember it.* After the conclusion of these investigations, he should take four days in which to think over the situation as observed. After the four days of *thinking,* he should write a specification, not exceeding 400 words in length, for some particular portion of the work or materials observed, giving special attention to covering the most ground possible with specified number of words.

Setting Terra Cotta. *Structural.* All furring terra cotta is to be set in Portland cement mortar. As a 1 to 4 mixture would be too short for the thin edges, the mortar must be a 1 to 2½ mix; one 30-d spike is to be driven into the brick mortar joints, with head projecting 1½ inches into furring joint for tie.

Ornamental. All joints are to be ½ inch thick, and special anchors, shown on the detail, are to be built in. Fill all hollow portions with concrete formed by running in cement mortar and then crowding in broken bricks until the mortar is forced into every corner.

Over all approximately horizontal surfaces, put a ½-inch coat of 1 to 1 Portland cement mortar, after covering the surface with a continuous sheet of No. 24 expanded metal. The terra cotta surface is to be thoroughly wet, the mortar coat pressed vigorously through the metal, and the surface finished smooth. This surface is to be protected from the sun for four days, and wet at such intervals as will keep it at all times moist.

CARPENTRY

Materials Required

Rough Lumber. All wood which is not exposed to view in rooms above basement, may be of pine, spruce, or hemlock, sized and seasoned.

Joists and Stringers. Joists and stair stringers must be sound, with no loose knots, or knots over 2½ inches, measured the longest way, within 3 inches of the lower or within 1 inch of the upper edge.

Studs. All miscellaneous studs must be sound, with no loose knots in either edge.

Rough Floors. There will be no wood floors in basement. Cover all joists and rafters with tongued and grooved pine or spruce boards, ⅞ inch thick and not over 5 inches wide, for lining. Shakes and other imperfections, which do not leave holes, will be accepted, provided the imperfection is of such a character that it will firmly hold a nail.

Miscellaneous. All miscellaneous framing lumber, bridging, etc., must be sound.

Finishing Lumber. *Floors.* All finished floors of the first ~~and second~~ story shall be of ~~quartered~~ white oak; and all floors above shall be of edge-grain pine, tongued and grooved, with not over 2½ inches face, thoroughly kiln-dried, and of a quality free from shakes. Sound knots will be allowed; also imperfections which do not extend to within ¼ inch of the wearing surface.

Basement. There will be no finish in basement, except door frames and doors, which will be stock pattern and paneled 1¾ inches thick.

First-Floor Rooms. The finishing lumber for all rooms on first floor except kitchen, pantries, and closets, shall be of quartered white oak, with bright surface, and with no imperfections which appear on the face or exposed edges; but sound knots of any size, which are finished smooth, will be allowed. All other finishing lumber of first and second floors is to be of ~~oak, ash, or birch~~ birch, of a quality specified above, but may be straight-sawed.

Second-Floor Rooms. All finishing lumber above ~~second~~ first floor is to be of pine, of a quality containing no defects which one coat of shellac and three coats of paint will not cover.

Shelving. All shelving in closets and pantries throughout the building, may be of pine or poplar, full ⅞ inch thick.

Stairs. All stair treads, rails, balusters, and risers are to be of ~~quartered~~ white oak, the treads to be 1⅛ inches thick, all strings to be of the same wood as the finish of adjoining floors.

Miscellaneous. All lumber for grounds, window-frames, etc., may be of pine or spruce, with square edges and free from loose knots.

Carpentry Construction

Framing. *Joists.* All *joists* are to be set 1 foot 4 inches on centers, with a bearing on all supporting walls of 4 inches. In brick walls, the ends are to be beveled so that the upper edge is just on a line with the inside face of wall.

Every third joist in the brick wall is to be anchored thereto by a strap anchor containing ½ square inch of metal, extending 2 feet onto the lower edge of joist and within 4 inches of the outside face of wall, the end turned up 2 inches, to be spiked to the joist with five 30-d nails to each anchor. Where joists meet over partition heads, they are to be spiked thereto with four 20-d spikes at each bearing, and, when practicable, to the joist of the opposite side. All joists are to be cross-bridged every 8 feet of clear span, with 2- by 2-inch stuff, with two 12-d nails in each end.

Trimmers. All *trimmers* are to be doubled, and all *headers* over 10 feet long are to be tripled. Where joists are framed together, no cutting is to be done; but wrought-iron hangers or

stirrups with a cross-section of all vertical parts equal to 1 square inch of metal, are to be used.

Studs. All studs are to be 1 foot 4 inches on centers, both studs and heads doubled beside and over all openings; and all openings over 4 feet wide are to be trussed above. Each stud is to be secured with four 12-d nails at each end, and to have one line of 2- by 2-inch single-bridging in the height of each story, this bridging to be so set in the center of the stud that it will be an inch back from both faces.

Rough Floors. The *lining floors* shall have two 8-d nails in each board over each bearing, one in the tongue and one about 1 inch from the groove edge. All lining shall be so laid as to be perfectly tight, and may be laid before plastering.

Sash. All *sash* shall be of pine, 1¾ inches thick. When only single sash are shown, they are to be hinged with three 3-inch wrought-iron butts at the top, and have two hooks to each sash to secure them when either closed or open. All other sash are to be double-hung with braided cotton cord and iron weights, the pockets of the window frames to be as long as practicable.

Finish. *Floors.* All *finished floors* shall have one 8-d nail over each joist; and, after being laid, they are to be scraped or planed to an even surface. These floors are to be laid after all other finish is in, and are to be cut with great care against the base.

Lumber. All *finish lumber* is to be put up in such a manner that the nails or screws securing it will be invisible. This is to be done by working through the back or in quirks or concealed places, but no splintering to hide the heads of nails shall be required.

Doors. The hardwood *doors* are to be veneered on soft white pine cores made of strips not over ⅞ inch thick. Before the veneering is put on, the Architect is to be advised where the cores may be inspected; and, if the gluing or seasoning is defective, or hard knots are discovered, the cores shall be rejected. The panels are to be left free to shrink. The doors below the third floor are to be 1¾ inches thick; those on third floor and above, 1⅜ inches thick.

Mantels. The *mantels* are to be built up complete, all parts glued together and nailed or screwed in concealed places, and brought to the building ready to set in place.

Hardware. The Owner shall furnish mortise locks complete, 3 butts for each door, 2 sash lifts, 1 sash lock, 1 socket, and 4 sash pulleys for each window.

The Contractor is to set these and to furnish and set any other hardware evidently necessary to complete the work—such as wrought-iron brackets for shelves, sliding-door hangers, etc.

Roof. The flat portions of the roof are to be covered with canvas. The steep portions shall be covered with tile.

Canvas. All canvas must weigh, when thoroughly dry, 10 ounces to the square yard, and must not lose over 5 per cent of its dry weight after being soaked in water 10 hours and so rubbed as to take out all matter soluble in water. It is to be laid dry, stretched tight, all edges to be lapped 1 inch and tacked with ¾-inch tacks set ¾ inch apart.

In all places where the roof meets a vertical surface, three-cornered strips, 1½ by 1½ inches are to be nailed, and the canvas is to be carried up over them and 8 inches on the vertical wall. If such wall is of masonry, there shall be a 1⅛-inch by 2½-inch dressed strip, fastened by expansion bolts set 3 feet apart under the projecting ledge of brick; the canvas is to be tacked to the underside of this strip, as at other places.

After the entire roof is covered and the canvas swept clean, it is to be soaked with water, and, when thoroughly wet is to be rubbed full of stiff paint composed of white lead and raw oil in proportions of 100 pounds of lead to 3½ gallons of oil. When this is dry and the surface hard—not less than five days after the first application—the roof and all exposed surfaces of wood strips in connection therewith are to have two coats of white lead and oil paint.

Tile. The steep portions of the roof are to be covered with red tile burned from a tough clay; and all nails or wire necessary to secure them permanently to the roof are to be of copper. If wire is used, the gage is to be not less than No. 12; if nails, the gage is to be not less than No. 8.

All joints are to be so close that there will be no necessity for waterproof paper below, or for cement, except at the hips.

All valleys are to be open, and flashed with 14-ounce copper, which *must* extend not less than 8 inches under the tile at each side.

NOTE TO STUDENT. No. 2.—See Note 1, on page 70, relative to examination of actual masonry work. At this point the student is to follow the directions in No. 1, only applying them to carpentry work and materials, and to write a specification (not exceeding 400 words) of some portion as directed in Note No. 1.

Gutters and Conductors. All gutters and exterior conductor pipes shall be of 16-ounce copper; where they join the soil pipe system, they are to be soldered to cast-brass thimbles, which are to be calked into the iron piping with pig lead.

PLASTERING

There is to be no plastering in the basement, but all the walls above are to be finished with three-coat work.

Lathing. All brick walls are furred with terra cotta, on which the plaster is to be placed. All other surfaces are to be

lathed with pine or spruce, only partially seasoned; and wherever these lathed partitions and the brickwork of chimneys or the terra cotta adjoin, expanded-metal or wire-mesh lath are to be placed, extending 8 inches on to each side; as each coat of plaster is placed, all corners are to be cut through from floor to ceiling.

Composition of Plaster. All plastering material is to be freshly burned stone lime, slaked at least two weeks before being mixed with sand; it is to contain hair of the ordinary quality sold for plastering purposes, and sand clean and sharp. The mixing is to be done just prior to its use, and is to be thorough. The hair is to be soaked so as to separate it, and enough must be used, and it must be so mixed that it will not be possible to find any small portions of the mortar in which the hair is not visible.

Application of Plaster. The first coat is to be mixed very rich with lime, using not more than 4 parts of sand to 1 of unslaked lime; it is to be scratched.

The second is to be a thin coat, in which 6 parts of sand may be used to 1 part of unslaked lime; this is not to be applied before the first coat is dry and hard.

The last coat in all cases will be white, a hard finish of lime putty gaged with plaster of Paris. This is to be applied in not less than five days after the first coats appear dry and hard.

The first two coats are to go to the floor back of all baseboards and wainscot, and be brought up to all grounds.

When completed, the work is to be straight and free from discolorations, hair cracks, or lime pits.

NOTE TO STUDENT. No. 3.—See Note No. 1 on page 70, relative to examination of actual masonry work. At this point the student is to follow the directions in No. 1, only applying them to plaster work and materials, and to prepare a 400-word specification of a portion of the work or materials, as explained.

PAINTING, VARNISHING, GLAZING

Painting of Exterior. All exterior woodwork is to be primed, as soon as in place, with raw linseed oil and a very small amount of yellow ocher; and later is to have two additional coats of raw linseed and white lead paint mixed in the proportion of 100 pounds of lead to 5 gallons of oil, colored with such pigments as will produce the single color desired; no more dryer is to be used in each coat than is necessary to insure its drying within 18 hours.

Painting of Interior. All pine woodwork throughout the house, including floors, shall have one coat of white shellac and three coats of paint, mixed as above, and of the colors selected by the Architect. There shall be one color only in each room for finish, and one for floors.

Hardwood Finish. All hardwood except floors is to be filled with a mineral filler, and to have three coats of varnish, the last two rubbed to a dull surface. The varnish is to be of a brand covered by an affidavit from the manufacturers that it contains no resin or petroleum products and that it has at least 17 per cent of copal gums. The varnish must also be of such a character that a film on glass will not dry in less than 48 hours, and when dry, the film is not to be brittle. Four days must elapse between the application of each coat of varnish and the succeeding coat.

All hardwood floors, treads, and risers are to have one coat of hot raw linseed oil and two additional coats of cold raw linseed oil, three days to intervene between each coat and the next.

Glass. All glass is to be at least $\frac{1}{8}$ inch thick and free from all smoke, bubbles, or wavy lines. It is to be set in the sash after priming with white lead, back-puttied, and fastened with points not over 6 inches apart and full-puttied.

PLUMBING AND GAS PIPING

Fixtures. *Bath.* The bathtubs are to be of porcelain, Class A, 5 feet long, glazed all over; with nickel-plated combined waste and bell supply fixture, with compression valves and china indexed handles, and $\frac{3}{4}$-inch iron-size brass supply pipes, nickel-plated. Over the Owner's tub there is to be an $8\frac{1}{2}$-inch tubular shower with hot and cold water through compression bibs with china indexed handles, nickel-plated curtain ring with white duck curtain, and nickel-plated chain and hooks.

Lavatories. The lavatories are to be of vitreous porcelain, 22 by 27 inches, with pedestal; they are to be fitted with combined waste and spout supply fixture, having china indexed handles, and an adjustable trap to wall, nickel-plated.

Water Closets. The water closets are to be of the siphon jet type, with white enameled seat and cover and vitreous porcelain low-down tanks with china lever handles, and brass floor flange with porcelain bolt caps. The flush pipe, vent extension, and seat hinges are to be white enameled.

Wash Trays and Sinks. The wash trays and sinks are to be of porcelain, Class B, white with integral back, porcelain legs and wall supports. The trays shall have $\frac{1}{2}$-inch brass waste plugs with a continuous brass waste pipe to the trap. They are to be supplied with hot and cold water through compression bibs with china indexed side handles. The sinks are to have a $1\frac{1}{2}$-inch outlet strainer and trap to wall, and to be supplied with hot and cold water through compression flanged bibs with china indexed handles. Ash drainboards are to be supplied, as shown. The trays and sinks must be glazed inside and outside.

Hot-Water Boiler. The hot-water boiler is to be of copper, of 60-gallon capacity, and tested to 200 pounds pressure. It is to be connected with the water front of the range, and have supply pipes, pressure regulator, relief valve, and sediment cock complete.

Piping. All cold-water piping is to be of lead, except in the basement, where it is to be of galvanized iron.

All hot-water piping is to be of iron-size brass, semi-annealed, with all fittings of heavy brass. All exposed piping in bathroom and toilet room is to be nickel-plated, in kitchen and laundry, polished brass.

From the end of the water main, now at the front wall, extend a 1¼-inch pipe to where the lead riser leaves the first floor level. This riser is to be 1 inch and to extend to the ceiling of the upper floor. The branch to the basement wash trays, from the 1¼-inch main, is to be ¾-inch, and that to the watercloset tank, ½ inch.

Above the basement, branches to sinks and watercloset tanks are to be ½ inch; to bathtubs and hot-water boiler, ¾ inch; and to lavatories, ½ inch.

Hot water from the boiler at the kitchen range is to be circulated to all fixtures except water closets in pipes of the above sizes.

All lead pipes are to be run on hardwood boards and through floor boxes, and to have tacks not over 2 feet 6 inches apart; where run horizontally, there are to be two brass bands between each pair of tacks, to prevent sagging.

No turn is to be made on a circle of less than 9 inches diameter; pipes are to be so carried as to provide a dead end of not less than 3 feet above the highest branch, and so graded that all will drain through a stop cock and waste cock to be set just inside the basement wall.

Joints. There are to be as few joints as possible in the lead piping; but where they occur, either in connection with lead or brass, the joints are to be wiped; if connections are necessary to iron pipes, brass ferrules, either calked or screwed into the iron pipe, are to be used.

Stop Cocks. Just inside the basement wall, and wherever a branch leaves the main in both hot- and cold-water lines, place stop cocks and waste cocks with a waterway equal to the area of the pipe in which it is placed, and with ¼-inch wastes to waste pipes or sewer. Those in the cellar are to be plain brass; and those above, nickel-plated, with lever handles.

Faucets. All faucets, except for bathtubs, are to be self-closing, of ⅛-inch larger waterway than the pipe supplying them; those in the wash trays and sinks are to be plain brass, those for bowls to be low-down nickel-plated.

The bathtubs shall be equipped with combination, compression bibs closing with the pressure, of the plainest and heaviest stock pattern, with a nozzle and to which a ½-inch hose can be attached.

Traps. Under the set of tubs, each sink, and bathtub, set a 4-inch lead pot trap, 8 inches deep, with a 4-inch brass trap screw in the top, set in an accessible place as near the fixture as possible.

Under each bowl set a nickel-plated trap which cannot be siphoned under any conditions existing in the building, and with no movable parts, but with a trap screw which will permit cleaning,

Soil Pipe and Connections. All soil pipe and fittings are to be of cast iron of the grade known to the trade as "Extra Heavy" —that is, the grade in which a 5-foot length of 4-inch pipe weighs not less than 65 pounds, and is coated outside and inside with asphalt paint. The main line extending from the running trap in the manhole to a point just above the highest fixture, is to be 4-inch; all branches to fixtures are to be of the smallest diameter allowed by the city ordinances, and are to be brought to points as near the fixtures as possible.

Above the highest fixture, a 4-inch wrought-iron fitting is to be calked into the cast-iron hub of the soil pipe, and continued with a 4-inch wrought-iron screw-jointed pipe into the flue for the kitchen range, and thence to top of chimney; but before the wrought pipe enters the flue, a right angle is to be formed in the screw-joint fittings, so that, in case of unequal settlement of any part, the screw joint in the angle will take up the movement.

Back air or vent pipes are to be installed only as required to comply with the city ordinances.

All soil and waste pipes are to be calked with pig lead.

As the details show the location of pipes and fittings required on the plumbing drawings, they are not described here.

All connections from bowls and sinks to traps and waste pipes and also from wash trays are to be of 1½-inch "n.p." brass. From bathtubs the waste pipes are to be 1½-inch "Heavy" lead; and the joints are to be formed as indicated above for water runs.

The waterclosets are to be set on and bolted to brass flanges above the floor, from which a 4-inch lead bend of 8-pound weight is to connect with a brass ferrule calked in the soil pipe.

The flush pipe connection from tank to watercloset is to be nickel-plated brass 2-inch pipe.

In carrying out the entire plumbing system, all pipes are to be run exposed, except where the soil pipe is continued in the flue. There is to be no cutting of timbers; and wherever pipes pass through partitions or floors, collars of the same material as the pipe are to be placed, except that where lead pipes are used, the collars are to be of nickel-plated brass.

Test. After the roughing-in of soil and waste pipe is complete, all outlets below the top are to be stopped, and the entire system is to be filled with water, which is to stand in the pipe without settlement for 10 hours.

Obedience to City Regulations. The requirements of the city ordinances are to be observed; but where this specification requires work or material in addition to that specified by the ordinance, the city regulations are not to be construed as relieving the Contractor from furnishing all that is herein specified; and when the work is completed, it must be in such condition that every fixture and pipe shall perform the functions pertaining thereto in a perfect manner.

Final Tests of Plumbing. It shall, further, be an obligation on the part of the Contractor to make the smoke-and-peppermint test of the entire system, when required, not less than 3 months after the occupancy of the premises; and previous to such tests, there is to be no tightening of unions or other screw joints. Any joints which then are not found to be perfectly tight, are to be opened, and such washers or other appliances placed as in the opinion of the Architect will make a permanent seal.

NOTE TO STUDENT. No. 4.—See Note No. 1 on page 70, relative to examination of actual masonry work. At this point, the student is to follow directions there given, only applying them to plumbing work and materials, and to prepare a 400-word specification of a portion of the work and materials, as explained.

Gas Piping. Inasmuch as the Gas Company lays down full and complete rules governing the sizes of pipes and methods of running them, which must be followed, this portion of the work is not set forth here, further than to require that such rules shall be followed. But in carrying out the work no joist is to be cut more than 1 inch deep, and never more than 8 inches from its bearing.

No vertical stud is to be cut more than 1¼ inches deep, and no vertical supporting timber or pier under any circumstances.

When complete, the system is to be tested, in addition to the Gas Company's test, with 15 pounds air pressure, which must be held for half an hour.

HEATING

The Owner shall furnish, deliver, and set up in the cellar, but without any smoke pipe or steam pipe connections, a cast-iron, sectional, low-pressure steam boiler; and the Contractor is to furnish and place all other necessary material and labor to install the system completely. All radiators are to be of cast-iron. The piping is to be so installed that all steam and condensed water in the same pipe will travel in the same direction, except that one

short connection to radiators may let in steam and take out water, so that only one valve will be required.

All radiator valves are to have unions, so that the radiator can be completely disconnected thereby, and are to be nickel-plated, with wooden handles.

The air valves to radiators shall be of the approved automatic type. All valves other than radiator valves in pipes shall be gate valves, allowing a full opening.

The sizes and positions of all radiators and pipes are shown on drawings Nos. 30, 31, 32, and 33.

The smoke pipe from the boiler is to be of No. 22 gage black iron, with riveted joints.

After the system of steam pipes and radiators is complete, it is to be tested with air pressure to 50 pounds; and the pressure is to stand one hour without showing any drop at the gage.

All radiators are to be bronze-painted; all pipes above basement are to be painted maroon, and all in basement black.

A brick wall is to be placed around the boiler, extending to the floor lining between the joists, leaving a space of at least 2 feet between boiler and wall at all points except in front. Overhead, nail to the joists No. 24 galvanized-iron sheets, above which, between the joists, put 2 inches of mineral wool.

From the chamber thus formed, take IX tin pipes (that is, pipe of tin on iron or steel plates which weighs approximately 9 ounces to a square foot before coating with tin) to the registers indicated on the First Floor Drawing. Each pipe is to have a damper completely closing the entire area. The registers are to have tight-fitting valves and cast-iron borders.

Build the cold-air box of No. 24 galvanized iron, with hinged valve closing the entire area, and with chain and weight competent to hold it in any desired position.

NOTE TO STUDENT. No. 5.—See Note No. 1 on page 70, relative to examination of actual masonry work. At this point the student is to follow the directions in No. 1, only applying them to heating apparatus, etc., and to prepare a 400-word specification of a part of the apparatus.

CLEANING PREMISES

After the work is practically completed, all surplus material and débris are to be removed from the premises; the building swept clean; windows washed; and the finish wiped off, so as to allow a final inspection of all visible points. Any items which are then passed as satisfactory shall be considered as fully complying with the contract requirements, unless there later appear hidden defects which at that time could not be seen.

FORMAL CONTRACTS

Contractors' Bids. Duplicate copies of the specifications given in the preceding pages are sent to various contractors and bids asked for. After proper analysis of the specifications and drawings, each contractor submits a sealed bid, preferably according to the following form:

PROPOSAL SHEET

....., the undersigned, hereby proposes to construct a dwelling for .....
in strict accordance with drawings numbered.....
and the foregoing specifications for the sum of.....
.....$.....
If light colored sand stone or lime stone is substituted for all face brick and ornamental terra cotta following the same outlines, add - - - - - - - - - - - $.....
If two months more time is allowed for the construction, deduct - - - - - - - - - - - - - - - - - $.....
If in the upper stories plain oak is substituted for painted pine, add - - - - - - - - - - - - - - - - $.....
Signed.....

Award of Contract. After the completion of the drawings and specifications, and due consideration of the bids received from the contractors who are asked to figure on the work, it is customary to award a contract—that is, to enter into an agreement for carrying out the work; and an instrument is drawn for the signature of both the owner and the contractor, setting forth their legal relations. Inasmuch as a contract between two parties is an agreement to do a certain specific thing, it is evident that the principal part of the contract, or the basis therefor, consists of the drawings and specification, in which is the full and complete description of the specific thing to be done. Hence, in the preceding text, the point that every requirement and condition should be clearly set forth, has been emphasized; for, however strong the formal contract may be, if it has no specific basis, it is of no value. Therefore, from a legal standpoint, emphasis is again placed on the necessity for a clear and unambiguous statement in the specification, of just what is to be done.

The *formal contract* is not drawn till after the award of the work; but separation in time does not change the fact that it is only a continuation of the specification; it is the completion of the latter, and it should, in short, clear terms, set forth the final arrangement.

As the province of the specification is to set forth and explain what is not included in the province of the drawings, the formal contract is to set forth such final conditions as the specification was not able to cover.

GENERAL CONTRACTS

Alterations in Work. There are certain conditions likely to prevail in carrying out the work, which may in a very material way affect the operation of the contract, and possibly destroy its force, notwithstanding the fact that its basis is sound. As the contract is an agreement to do a certain specific thing, it follows, that, if any change is made in any of the matter which goes to make up that specific thing so that some other specific thing is substituted, the terms of the contract are not filled; and such a change, unless properly guarded, can be made the basis of refusal on the part of either the owner or the builder to abide by all the conditions covered by the contract. Questions of this description are among the most serious which arise in general architectural practice.

As buildings progress, the owner and often the architect see items which, if changed, would improve the result; and as the departure from the specific thing contracted for appears slight, the builder is, in a general way, either requested or directed to make the change. Also, in the progress of the work, the builder often finds it possible for him to make better arrangements for materials, etc., by making substitution, and, considering the change of little moment, he proceeds to make it.

In the first of the cases above cited, the owner or the architect is surprised when he finds that modifications made are the basis for an extra charge of some magnitude; and that they are also used as an excuse (and it is generally valid) for several days' delay in the completion of the work.

In the second case, the builder is surprised to find his substitution the basis of a demand that he make a material deduction from the contract price.

In either case, the architect is blamed by both parties—and often justly so—for allowing matters to drift into the existing conditions; and it is not unusual for the owner and builder to get together and settle their differences, without changing their opinion of the architect.

Therefore, after the signing of the contract, it should be the special province of the architect to see that as few changes as possible are made; and, when it is advisable to make changes, to be certain that all the conditions affected thereby are fully understood, and that such understanding is expressed in writing signed by both parties.

It is not the intention here to intimate that desirable changes should be abandoned in order to avoid complicating the contract situation, because there is no work in which improvements cannot be made as it progresses; but emphasis is laid on the suggestions that such changes should be as few as possible, and should never be allowed at all unless there is a distinct advantage gained to the *owner,* and that, in consenting to any changes, the case should be put in such formal shape that there can be no later misunderstanding.

Prompt Preparation of Detail Drawings. As the question of time is generally important to the owner, the architect should see that all detail drawings are furnished within the specified time, as it is unreasonable to expect the builder to complete the work on time if he is delayed in the receipt of the drawings. A delay is generally a sufficient excuse for extension of the contract time for completing the work. Special care should be taken that the modification in the details be not of such a character as can be used as a basis for demands for extra compensation beyond contract prices.

Agreement between Owner and Builder. Under the ordinary conditions that prevail in private practice in work that is not of great magnitude, a simple document is all that is necessary to set forth the final relations of owner and builder, in form somewhat as follows:

FORM OF AGREEMENT BETWEEN OWNER AND BUILDER

AN AGREEMENT entered into this 15th day of March, 1916, by and between....., of Chicago, Owner, party of the first part, and....., also of Chicago, Builder, party of the second part:

WITNESSETH: That the said party of the second part, for and in consideration of the sum of Five Thousand ($5,000.00) Dollars, in payments as set forth in the specification, agrees to construct a city dwelling for the said party of the first part, at the corner of.....Ave. and.....St., city of Chicago, in accordance with drawings numbered.....and specifications, all prepared therefor by....., Architect.

Which drawings and specifications are a part of and the basis of this agreement.

IN CONSIDERATION of the foregoing, the said party of the first part agrees to pay to the said party of the second part the full sum of Five Thousand ($5,000.00) Dollars, in payments and under conditions as fully set forth in the specification.

In witness of the foregoing, the parties aforesaid here set their hands and seals to this and one other instrument of like tenor and date, this..... day of ....., 1916.

....., Owner (Seal)

....., Builder (Seal)

In presence of:

.....

.....

Should changes be necessary, a supplementary agreement in the following form should be prepared for the signature of both parties:

WHEREAS: ....., Owner, did, on the fifteenth day of March, 1916, enter into an agreement with....., Builder, for the erection of a dwelling in accordance with drawings and specification prepared therefor by....., Architect, as fully set forth in such agreement; and

WHEREAS: it is the desire of said....., Owner, to make certain changes as fully set forth as follows:

.....

.....

The said....., Builder, agrees to make such changes and make all necessary modifications in the work necessarily incident thereto, for the sum of One Hundred ($100.00) Dollars, as an addition to the original contract price for the work, it being understood that no additional time is to be required in the completion of the work on account of these changes.

And the said....., Owner, agrees to pay the additional sum of One Hundred ($100.00) Dollars on account of these changes.

In witness of the foregoing, the parties aforesaid have set their hands and seals to this and one other instrument of like tenor and date this..... day of....., 1916.

....., Owner (Seal)
....., Builder (Seal)

In presence of:

.....
.....

The above agreement has been duly noted by me,

....., Architect

Architect's Monthly Reports. As the work progresses, it will be necessary for the architect each month to make an estimate of the value of the labor and materials satisfactorily in place, and to issue to the contractor a certificate for presentation to the owner. A certificate not only serves its purpose of notifying the owner of the amount due, but also furnishes him with a statement of the account to date. It is very desirable that both owner and contractor shall each month see, understand, and sign a clear statement of the conditions existing under the contract; for this closes up all matters which if allowed to drift, might cause serious misunderstanding. The form of certificate is given below.

Certificate No. 2.

CHICAGO, ILLINOIS
May 1, 1916

THIS certifies that....., Contractor, under his agreement, dated March 15, 1916, with....., to construct a dwelling at the corner of.....Ave. and.....St., city of Chicago, is entitled to a payment in amount Twelve Hundred Dollars ($1,200.00) under the terms of said agreement in accordance with the following statement of the account:

Contract price		$5,000.00
Extra No. 1, dated April 3, 1916		100.00
Extra No. 2, dated April 18, 1916		125.00
Total of contract and extras to date		$5,225.00
Value of work and materials satisfactorily in place at this date		
Retained percentage 10%	$ 240.00	
Certificate No. 1, April 1, 1916	960.00	
Certificate No. 2, May 1, 1916	1,200.00	
Total value of work in place on this date		$2,400.00
Total balance unpaid under this contract		$2,825.00

To....., Owner. ....., Architect.

May 3, 1916.

RECEIVED from....., Owner, the sum of Twelve Hundred Dollars ($1,200.00), and I acknowledge that the above statement of the account is complete and correct.

....., Contractor.

RECEIPT FOR INSURANCE POLICIES

(To be detached and delivered to Contractor after signing)

RECEIVED of..... ....., Contractor, fire insurance policies as follows: .....in total amount $2,600.00, issued as required by agreement dated March 15, 1916, for the erection of a dwelling for me at the corner of.....Ave. and.....St.

....., Owner.

Contracts That Require Bonds. In all the foregoing relative to formal contracts, consideration has been given only to such cases as would come up in an ordinary private practice, where it is taken for granted that the relations of parties with one another are such that all that is necessary to insure a satisfactory completion of all agreements is a definite understanding of exactly what is to be furnished and done by each of the contracting parties. No contracts can be drawn, or specifications written, which prevent either party from bringing suit against the other if he so desires.

The question is entirely different in the case of formal contracts for public or corporation work requiring bonds where, on account of the impersonal nature of the owner, it is impossible to adapt procedure to the varying conditions that arise. It is entirely outside the province of the architect to attempt to arrange details of a legal nature in such cases. The liability of a bondsman is very peculiar, and he can be relieved therefrom because of even very small departures from the agreement. Thus changes in the work or material, changes in the dates or manner of payment, changes in time of completion of the work, etc., can be set up (and generally with success) as reasons why the obligations under the bond should be set aside.

As a general thing, bonds are now furnished by large corporations who employ the best of legal talent to dispute, on any ground, their liability should they be called on; and it is unreasonable for an architect to attempt to protect his patron's interest under such circumstances. Therefore, in cases of this nature, the attorney

representing the public body or the corporation for which the work is to be done, should draw the formal contract and bond, and supervise their execution. Any action during the progress of the work which could in any way affect the specific obligations of either party, should be passed on by such attorney; and, in case of any change, he will obtain a formal consent of the sureties on the bond, before its final ratification.

GOVERNMENT CONTRACTS

It is not generally known how extensive are the building operations of the Treasury Department of the United States, or how greatly its demands for material and labor influence the market; nor do many contractors or material men know much about the nature of the contracts to be awarded. There is, besides, a kind of superstition that such contracts are so bound up in red tape that it is wise for contractors and men with good material to keep out of this market. It is the object of this section to show the amount of work which is under the control of the Treasury Department; to indicate its general nature and the conditions under which contracts are let and the work executed, and which govern the furnishing of materials; and to explain the nature of the formal contract and in what respects it differs from those usually required between individuals.

Government work is not all red tape. In fact, when the reasons for certain fixed lines of action are understood, the red tape appears in the light of necessary business machinery, which, if more frequently applied with discretion to private enterprises, would assist in producing results far in advance of the average now obtained.

Number and Value of Government Building Contracts. There are at times under contract, wholly or in part, or awaiting contracts which will usually be awarded within two years, nearly two hundred fifty buildings, the cost limit of which, including sites, would be fixed by Congress at approximately $40,000,000. Placing the cost of sites at about 20 per cent of the total, it will appear that the buildings will require in material and labor over $30,000,000. At the rate at which work is generally carried on, the disbursements involved through the different channels would be from $600,000 to $1,000,000 *a month.* While there are many corporations in the

world disbursing an equal sum for materials and labor required in industrial enterprises, there is probably none where such large sums are disbursed through general channels open to so many branches of industry.

Character of Buildings and Their Fittings. The buildings under the control of the Treasury Department are for the use of the civil branches of the Government, such as Postoffices, Courts, Customs, Internal Revenue, Marine Hospitals, and Quarantine Stations. Such buildings as the Capitol, the Library of Congress, and the executive buildings of the different Departments at Washington, are not under the control of the Treasury Department nor built by it; neither are forts or other Army or Navy buildings, or United States jails.

Many of the buildings under the Treasury Department are very large and expensive, the New York Custom House and the Chicago and San Francisco postoffices being buildings of this type. The larger number, however, are of moderate size, ranging from structures of 40 feet by 80 feet outside dimensions and one story high, to buildings of three times that area and three stories high, costing complete, with heating apparatus, etc., from $35,000 to $175,000 each.

The large majority are of fireproof construction and classic design, with interior finish of hardwood and marble where the funds permit. The best of materials and appliances are used throughout, as it is inadvisable and almost impracticable in public buildings of this character to exercise the many economies which prevail in private building.

The interiors are fitted with the best of modern appliances and conveniences; plumbing is extensive and of the most modern kind; the toilet rooms for postoffice carriers are supplied not only with the usual appliances, but often with shower-baths; and no woodwork, either in floors or in finish, is allowed. Throughout the building, small private toilet rooms are provided for the more prominent officials; and in many, especially in the south, bathtubs are supplied. The heating, ventilating, and electric work are, in their way, equally complete.

The buildings in the larger cities where the Railway Mail Service men change, have dormitories for the accommodation of from

ten to seventy-five men. In the postoffice proper are galleries with openings commanding every corner accessible to the men, from which inspectors can watch for days, without arousing suspicion, any person suspected of pillaging the mails.

There is always a large "swing room" for carriers when off duty, where they have games, boxing gloves, and occasionally a billiard table for recreation.

In the larger postoffice buildings there are the most elaborate mechanical equipments, engines, boilers, electric generators, elevators, mail-carrying and handling devices, sweeping machinery, etc.

From the foregoing it is evident that there are few lines in the building industries which should not be interested in the erection and furnishing of these many buildings.

Building Conditions. It is a matter of interest to a very large body of contractors, subcontractors, artisans of all callings, and material men, and manufacturers, how the Department builds, and in what ways it differs from the average investor in its building operations and contracts.

There is a prevalent idea that mystery surrounds the act of securing the whole or any part of a government contract—that one must be on the inside and know how to pull the wires. This feeling arises probably from the facts that the Government as an employer and owner is a very different affair to deal with from a personal owner; and, because of such difference, and because of the magnitude of the varied branches of work, rendering it necessary to have some fixed and unyielding rules and regulations to which all doing business with the Government must comply, the great mass of people who should be interested are likely to think that this is all red tape, and that they cannot get near any of this work.

Exactness and Rigidity of Contract. When the owner and the contractor in ordinary practice make an agreement, it is always modified by the personal conditions and qualities of each, so that the conditions and terms frequently differ materially in instances of work of the same character. With the Department, however, this cannot be. The Department has fixed policies and rules, and is hedged about by law in such a way that it must be unyielding at all points; it cannot adapt the work to the conditions of the con-

tractor; it can take no chances; and anyone seeking to do business with the Department must lay aside all personal ideas of methods, and must seek from the first to get into the line of the Department's method and requirements, even if these appear to be without reason. The contractor who imagines that he can take a contract, and can afterward have its lines modified to suit his own methods, which he may honestly believe to be better than the requirements of the Department, is not only bound to be disappointed, but is certain to lose a round sum before final settlement.

When bids are asked for the construction of a building, the drawings and specifications are so prepared that the bidder is given notice relative to every requirement; nothing is taken for granted; it is fully set forth to what extent he is to be responsible for the completion of the work, and he is shown all details leading up to such completion. How and when each payment shall be made, is fully explained. Many of these requirements are unusual; the builder may not, and probably does not, understand why they are inserted; but that is really none of his business; the requirement is plainly stated, and if he wants to put in a bid, he has but to figure just what the cost of the apparently useless requirements will be, and to add such amount to his bid.

The conditions which govern Treasury contracts are the result of the experience of many years; and if a greater proportion of private owners and contractors for private work would adopt similarly exact methods in their operations, their work would be attended with much fewer annoyances and much less friction. The Department is just as rigid in not permitting a contractor to furnish something for nothing, as it is in not permitting him to substitute a poorer article than that required by the contract. Should the contractor under any circumstances make a substitution, he is never safe. The superintendent on the work may pass it; but the contractor never knows when some traveling inspector or other official may arrive and detect the change. In that case, the superintendent, as well as the contractor, receives severe censure, and the contractor has either to rectify the trouble or to consent to a deduction of a good round sum, which usually represents several times the difference in value between the material furnished and that required.

Final Authority in Disputes. It is fully set forth in the specification that, in case of dispute regarding what is required or regarding the value of extra work, either as an addition or as a deduction, the decision of the supervising architect is to be final; and this means more than such clauses in private specifications, for the Department cannot be sued, and, in case the contractor objects to the ruling and stops work, the Department has the power to abrogate the contract and to finish the work at the expense of the sureties on the contractor's bond. Later the contractor can bring a suit in the Court of Claims; but it is very rarely that any substantial change is made in the original rulings. This rather autocratic power appears one-sided, and at first thought unfair; and, because of such appearance, it is never exercised except under extreme conditions, after every effort at reasonable settlement has failed; and then the decisions are such that, as above stated, the Court of Claims rarely reverses them to any extent.

This power is necessary for the Government; otherwise the Department would be at all times subject to inroads and impositions which would make progress impossible.

Rights of Subcontractors and Material Men. The subcontractor and material man has no right of lien; but he has a right, after a certain lapse of time, to bring suit against the contractor; moreover the bond required by the Government, equal to one-half of the contract price, is also for his benefit, so that he has the same protection under the bond as has the Department. Upon application, certified copies of all contracts and bonds are furnished for his use by the Department, free. But the Department is under no obligation, nor has it any right, to withhold payments from the contractor at the request or demand of unpaid creditors.

The relations of subcontractors and material men at the Department are peculiar in that they cannot in any way be recognized in a business connection; they have no more connection with the Department than a factory which makes the shoe sold by a dealer has with the customer. The contractor is the only business man known or recognized; all business of whatever nature must come under his signature. A subcontractor can get no information or directions from the Department's representative. If it were otherwise, the contractor would have just cause for

complaints relative to the Government's interference with his business.

Provisions for Competitive Bids. Many years ago a Departmental order forbade the requirement of any particular item which might limit competition, or the mention of any particular material or appliance, "or its equal"; as a consequence, there must be inserted in the specification such descriptions as will require appliances or materials which can be had through competition and which will accomplish the ends required. The contractor is at liberty to obtain his samples for approval in any market he desires; but when such samples are approved, it is a very difficult matter to have a change authorized; were it otherwise, the Department would be constantly annoyed and delayed in its work by contractors changing their minds relative to the parties with whom they wish to deal.

It is often urged by persons controlling some new and special appliance, that it is not good business for the Department to refuse to specify an article having all the desirable points which it is evident, they maintain, belong to the particular article controlled by them. If this idea governed, the office of the supervising architect would be overwhelmed by enthusiastic men with material and appliances of very doubtful value, the claims of which would be generally urged with a strenuousness in direct proportion to their worthlessness.

Experience has also shown that where competition relative to items entering into work has not existed, the persons controlling the appliances used rarely resist the temptation to charge abnormal prices. This results in the contractor seeking relief at the Department and asking to be permitted to make a substitution; if his request is granted, the higher bidders at once set up the claim that their figures were based on the specified requirements, and if they had known that such were not to be enforced their bid would have been low enough to capture the contract.

Changes in Contract. After a contract is once made, no one other than the Secretary of the Treasury, or, under certain circumstances, an Assistant Secretary, has the authority to make a change, no matter how small. The superintendent on the work can allow no variations; nor has even the supervising architect himself any authority to make a change. For instance, two rough coats of

plaster are required back of a certain wainscot, but it is found advisable to omit the second; the area is small, and the difference in expense nothing. But the superintendent must obtain from the contractor a proposal to omit this coat without expense to the Government; and after this proposal has gone through the different divisions of the supervising architect's office for note, comment, and recommendation, the Assistant Secretary accepts the proposal in regular form as a public exigency, and with the understanding that it is not to affect the time for completion, or the obligation of the sureties on the bond, etc. If it were otherwise, the superintendent would be constantly harassed by requests and arguments for changes; and if he permitted changes, the worst of motives would be imputed to him.

Justice in Government's Methods. So thorough is the system in the Department, that there is no detail too small for the fullest consideration. There is probably no architect's office elsewhere in the world where all details receive such attention; and there are few transactions of any nature occurring within recent years, of which all details cannot be obtained by any official in the office in less than ten minutes.

When the red tape of the Department is considered from various standpoints, and the results reviewed, it should inspire more respect than is usually accorded to it; and the man who is seeking contracts or subcontracts should first of all get into the spirit of the business methods of the Department, make his bid to cover all its requirements, and, if he gets the contract, use his best efforts to live up to the letter of every requirement. Such methods will bring success; carelessness will bring failure.

It is often stated that such and such persons have the "inside track" with Departmental work, and that there is no use bidding against them. This is in a sense true; but in all such cases it will be found that that "inside track" was laid by the contractor getting in line with the Department's methods and doing business as thereby required; and the way is open for any other man to lay for himself such an *"inside track."*

Methods of Soliciting Bids. There is a prevalent impression that it requires some special effort to have an opportunity to figure on Department work. There could, however, be no greater mistake,

as every effort is made by the supervising architect to obtain the best competition. For every building, from forty to sixty sets of drawings and specifications are printed and sent without charge (being carried both ways free) to any *general contractor* who makes an application. In a very few instances a certified cheque is required, the proceeds of which are returned upon the receipt of the drawings, etc., in the office. Subcontractors and material men cannot be supplied with drawings and specifications, as it is impracticable to make a sufficient number of sets, and for the further reason that it is desired that subcontractors and material men shall get all the information on which they base their bids from their principals, thus avoiding the danger of differences of opinion that might arise relative to the scope of the sub-bids.

When bids are wanted, the work is advertised for from four to seven weeks, in representative technical journals throughout the country in the general section in which the work is to be done, and in the local papers of the town or city in which the building is to be erected. Notices as news items are sent to a very large line of trade papers, and also to contractors within a few hundred miles of the city whose addresses are available; but such notices are discontinued if the party addressed does not submit a bid after notices of several buildings have been sent.

Many material men send in requests that their specialties be required, and when they find that that cannot be done, they drop all interest; whereas, if they followed up the matter, ascertained to whom the contract was awarded, and endeavored to arrange to sell any materials handled by them required under the contract, they would often obtain profitable contracts.

Specimen Contract. In order that the exact nature of the form which has to be signed by parties to whom contracts for Treasury buildings are awarded may be seen, a specimen contract is herewith reproduced, with occasional notes in smaller type to explain its provisions. The form of bond is also printed; but, as this varies little from that used in private contracts, no notes in explanation of the provisions of the bond will be found necessary.

CONTRACT

BETWEEN THE

UNITED STATES OF AMERICA

AND

JOHN DOE

WHEREAS, By advertisement, duly made and published according to law, proposals were asked for furnishing all of the labor and materials for the work herein provided for; and

WHEREAS, The proposal of JOHN DOE..... furnished in response thereto, was duly accepted, as hereinafter stated, on condition that he execute a contract in accordance with the terms of said bid.....

NOTE.—The *practical award* of the contract is a letter written by the Assistant Secretary of the Treasury (under written authority of the Secretary) to the successful bidder, accepting the bid and stating the principal conditions which are to govern—such as the price to be paid, time for completion—approving such appliances as have in the proposal sheet been offered for carrying out the contract (provided such are satisfactory), and settling the amount of bond to be furnished. This letter, referred to below, is attached to, and made a part of, the formal contract.

NOW, THEREFORE, THIS AGREEMENT, made and entered into by and between....., Secretary of the Treasury, for and in behalf of the United States of America, of the first part, and John Doe,

.....

.....

...., of the second part,

WITNESSETH: That the party of the second part, for the consideration hereinafter mentioned, covenants and agrees to and with the party of the first part to furnish all of the labor and materials and do and perform all the work required.....

.....

.....

.....

in strict and full accordance with the requirements of drawings numbered

.....

.....

.....

and such other detail drawings as may be furnished to the party of the second part by the Supervising Architect of the United States Treasury Department; the advertisement for proposals, dated..... 190 ; the specification for the work; the proposal dated..... 190 , addressed to the said Supervising Architect by the said party of the second part; and letter dated.....190, addressed to the said party of the second part by.....

.....Assistant Secretary of the Treasury, accepting said proposal; .....

.....

.....

(2)

NOTE.—The proposal often covers several pages. First the lump sum price is stated for the entire work; then follow many *Alternates*—that is, the amount the bidder will add or deduct provided certain materials are substituted for those required by the straight bid—as, for instance, the amount to be deducted for "Alternate A," substituting brick for all plain surfaces of the

Superstructure above 1st floor line ..... $.....

After the alternates, *unit prices* are given. Thus:

Price per thousand for common brick in place.....$.....

After this are lists of appliances to be used in the work. Thus:

Name of boiler proposed to be used.....

Number of square feet of grate surfaces.....

Etc., etc.

a true and correct copy of each of which said papers is attached hereto and forms a part of this contract; and which said numbered drawings, bearing the signature of the said Supervising Architect and the signature of the said party of the second part, are on file in the Office of the Supervising Architect of the United States Treasury Department, and are hereby made part of this contract.

And the said party of the second part further covenants and agrees that the work herein agreed to be performed shall be commenced promptly upon receipt of notice of the approval of the bond hereto attached, and that the same shall be carried on in such order and at such times and seasons, and with such force as shall from time to time be directed or prescribed by the Supervising Architect or his representative, and that the same shall be completed in all its parts within.....

.....

from the date of the approval of said bond hereto attached; that all materials used shall be of the very best quality of their respective kinds; that all the work performed shall be executed in the most skilful and workmanlike manner, and that both the materials used and the work performed shall be in every respect to the entire and complete satisfaction of the Supervising Architect.

And the said party of the second part expressly covenants and agrees that the bond hereto attached shall be security, also, for the satisfactory performance and fulfilment of all the guarantees set forth in or required by said specification.

.....

.....

NOTE.—No official has any right to permit a Contractor to do any work under the contract until the bond has been formally approved.

It is expressly convenanted and agreed by and between the parties hereto that time is and shall be considered as of the essence of the contract on the part of the party of the second part, and in the event that the said party of the second part shall fail in the due performance of the entire work to be performed under this contract, by and at the time herein mentioned or referred to, the said party of the second part shall pay unto the party of the first part, as and for liquidated damages, and not as a penalty, the sum of.....dollars for each and every day the said party of the second part shall be in default, which

(3)

said sum of.....dollars per day, in view of the difficulty of estimating such damages with exactness, is hereby expressly fixed, estimated, computed, determined, and agreed upon as the damages which will be suffered by the party of the first part by reason of such default, and it is understood and agreed by the parties to this contract that the liquidated damages hereinbefore mentioned are in lieu of the actual damages arising from such breach of this contract; which said sum the said party of the first part shall have the right to deduct from any moneys in its hands otherwise due, or to become due, to the said party of the second part, or to sue for and recover compensation or damages for the nonperformance of this contract at the time or times herein stipulated or provided for.

NOTE.—The question of *actual* damages is always a very difficult one to settle, and generally involves a lawsuit; therefore the contract states the amount of *liquidated* damages, or the amount settled and fixed in advance by both parties to be paid by the Contractor in case of default. While this amount is rarely less than $20.00 a day, with an average of about $40.00, the Secretary of the Treasury is empowered by Congress to remit so much as will reduce such sum to one that in his judgment is right; and as a matter of fact, it is usual to assess only such an amount as will cover the actual expense of maintaining a Superintendent on the ground, and any items of rent, etc., and additional inspections for which the Department has actually to pay on account of the failure to complete within contract time.

The party of the second part further covenants and agrees to hold and save the United States, its officers, agents, servants, and employees, harmless from and against all and every demand, or demands, of any nature or kind, for, or on account of, the use of any patented invention, article, or appliance, included in the materials hereby agreed to be furnished under this contract.

It is further covenanted and agreed by and between the parties hereto that the said party of the second part will, without expense to the United States, comply with all the municipal building ordinances and regulations, in so far as the same are binding upon the United States, and obtain all required licenses and permits, and be responsible for all damages to person or property which may occur in connection with the prosecution of the work; that all work called for by the drawings and specifications, though every item be not particularly shown on the first or mentioned in the second, shall be executed and performed as though such work were particularly shown and mentioned in each, respectively, unless otherwise specifically provided; that all materials and work furnished shall be subject to the approval of the said Supervising Architect; and that said party of the second part shall be responsible for the proper care and protection of all materials delivered and work performed by said party of the second part until the completion and final acceptance of same.

NOTE.—Municipal laws are binding on the Government to a very limited extent, and only outside of the lot line; the land, when bought by the Government, not only becomes its property, but it is, by such sale, *ceded* back to the United States, so that the land occupied by the public building is no longer a portion of the State, and the State or City has no more authority over it than it has over the District of Columbia.

Cases sometimes occur when some city official attempts to show authority, as in one case where a permit to enter the sewer was denied until some minor useless demand

(4)

relative to the plumbing was complied with. The official had a perfect right to refuse the permit as the sewer was in the street; but after the Department had decided not to turn on the water, and to leave all plumbing fixtures unusable, the official soon found it better policy to allow the connection. This policy is always followed by the Government, as the practice of the Supervising Architect's office in all matters of this sort is the best, and is generally far better than that followed by many municipal laws.

Inside the lot lines, municipal and state authority do not exist, except for minor police regulations.

It is further covenanted and agreed by and between the parties hereto that the said party of the second part will make any omissions from, additions to, or changes in, the work or materials herein provided for whenever required by said party of the first part, the valuation of such work and materials to be determined on the basis of the contract unit of value of material and work referred to, or, in the absence of such unit of value, on prevailing market rates, which market rates, in case of dispute, are to be determined by the said Supervising Architect, whose decision with reference thereto shall be binding upon both parties; and that no claim for damages, on account of such changes or for anticipated profits, shall be made or allowed.

It is further covenanted and agreed that no claim for compensation for any extra materials or work is to be made or allowed, unless the same be specifically agreed upon in writing or directed in writing by the party of the first part; and that no addition to, omission from, or changes in the work or materials herein specifically provided for shall make void or affect the other provisions or covenants of this contract, but the difference in the cost thereby occasioned, as the case may be, shall be added to or deducted from the amount of the contract; and, in the absence of an express agreement or provision to the contrary, no addition to, or omission from, or changes in the work or materials herein specifically provided for shall be construed to extend the time fixed herein for the final completion of the work.

NOTE.—The somewhat arbitrary power referred to in the foregoing, is, as a matter of fact, rarely exercised; and when exercised, the greatest care is taken to make the amount such that it cannot be questioned. Sometimes Contractors imagine that, having the contract, they can demand for extras an exorbitant price, and they would be successful in many cases but for this saving clause.

It is further covenanted and agreed by and between the parties hereto that all materials furnished and work done under this contract shall be subject to the inspection of the Supervising Architect, the superintendent of the building, and of other inspectors appointed by the said party of the first part, with the right to reject any and all work or material not in accordance with this contract; and the decision of said Supervising Architect as to quality and quantity shall be final. And it is further covenanted and agreed by and between the parties hereto that said party of the second part will without expense to the United States, within a reasonable time to be specified by the Supervising Architect, remedy or remove any defective or unsatisfactory material or work; and that, in the event of the failure of the party of the second part immediately to proceed and faithfully continue so to do, said party

(5)

of the first part may have the same done and charge the cost thereof to the account of said party of the second part.

It is further covenanted and agreed by and between the parties hereto that until final inspection and acceptance of, and payment for, all of the material and work herein provided for, no prior inspection, payment, or act is to be construed as a waiver of the right of the party of the first part to reject any defective work or material or to require the fulfilment of any of the terms of the contract.

It is further covenanted and agreed that the party of the first part shall have the right to require that any particular portion of the work herein provided for shall be completed within such time as may be hereafter definitely specified by the said party of the first part in written notice to the said party of the second part; and that should the said party of the second part fail to complete such particular portion of the work within the time so specified, or fail to complete the entire work contemplated by this contract within the time or times herein stipulated or provided for; or fail to prosecute said work with such diligence as in the judgment of the party of the first part will insure the completion of the said work within the time hereinbefore provided, the said party of the first part may withhold all payments for work in place until final completion and acceptance of same, and is authorized and empowered, after eight days' due notice thereof in writing, served personally upon or left at the shop, office, or usual place of abode, or with the agent of the said party of the second part, and the said party of the second part having failed to take such action within the said eight days as will, in the judgment of the said party of the first part, remedy the default for which said notice was given, to take possession of the said work in whole or in part and of all machinery and tools employed thereon and all materials belonging to the said party of the second part delivered on the site, and, at the expense of said party of the second part, to complete or have completed the said work, and to supply or have supplied the labor, materials, and tools, of whatever character necessary to be purchased or supplied by reason of the default of the said party of the second part; in which event the said party of the second part shall be further liable for any damage incurred through such default and any and all other breaches of this contract.

It is further covenanted and agreed that the said party of the first part shall have the right of suspending the whole or any part of the work herein contracted to be done, whenever, in the opinion of the Supervising Architect, it may be necessary for the purposes or advantage of the work, and upon such occasion or occasions the said party of the second part shall, without expense to the United States, properly cover over, secure, and protect such of the work as may be liable to sustain injury from the weather, or otherwise; provided that for all such suspensions and other delays caused by the said party of the first part the party of the second part shall be allowed one day additional to the time herein stated, for each and every day of such delays so caused, in the completion of the contract, the same to be ascertained by the Super-

(6)

vising Architect; provided, that no claim shall be made or allowed to the said party of the second part for any damages which may arise out of any delay caused by the said party of the first part.

And the said party of the first part, acting for and in behalf of the United States, covenants and agrees to pay, or cause to be paid, unto the said party of the second part, or to the heirs, executors, administrators, or successors, of the said party of the second part, in lawful money of the United States, in consideration of the herein recited covenants and agreements made by the party of the second part, the sum of.....

.....

.....

And the party of the first part covenants and agrees that payments will be made in the following manner, viz: ninety per cent of the value of the work executed and actually in place, to the satisfaction of the party of the first part, will be paid from time to time as the work progresses (the said value to be ascertained by the party of the first part), and ten per cent thereof will be retained until the completion of the entire work, and the approval and acceptance of the same by the party of the first part, which amount shall be forfeited by said party of the second part in the event of the nonfulfilment of this contract; it being expressly covenanted and agreed that said forfeiture shall not relieve the party of the second part from liability to the party of the first part for any and all damages sustained by reason of any breach of this contract; provided, however, that no payment hereunder shall be due to the said party of the second part until every part of the work to the point of advancement reached—on account of which payment is claimed—shall be found to be satisfactorily supplied and executed in every particular and any and all defects therein remedied to the entire satisfaction of the said party of the first part.

It is an express condition of this contract that no Member of Congress, or other person whose name is not at this time disclosed, shall be admitted to any share in this contract, or to any benefit to arise therefrom; and it is further covenanted and agreed that this contract shall not be assigned.

IN WITNESS WHEREOF, The parties hereto have hereunto subscribed their names this.....day of.....A.D. 190 .

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

All erasures, alterations, and interlineations to be noted here before execution.

(7)

We hereby certify that this contract and bond have been correctly prepared and compared:

.....
Chief of the Law and Records Division.

.....
Superintendent of the Computing Division.

.....
Secretary of the Treasury.

Witnesses to the signature of the Contractor:

Two witnesses.

.....

.....

.....
Contractor.

Place corporate seal here.

NOTE.—The above relates to one of the most vexing questions both to the Contractor and to the Department, which is encountered. When a Contractor gets hopelessly in default, it is as bad for him as for the Department to try to push through In such cases he is credited with the full value of all labor and materials on the ground; but for all additional items to complete the work covered by the contract, the sureties on his bond have to pay. Usually the bondsmen take the contract to finish the work; and in most cases, so far as the Department is concerned, no litigation follows.

---

(1)

BOND

KNOW ALL MEN BY THESE PRESENTS, That we,.....
.....
.....
of the City of....., County of....., and
State of....., principal , and.....
.....
.....
of the City of....., County of....., and
State of....., and.....
of the City of....., County of....., and
State of....., suret....., are held and firmly bound unto the
United States of America in the sum of.....dollars
($.....), lawful money of the United States, for the payment of
which, well and truly to be made to the United States, we bind ourselves,
our heirs, executors, administrators, successors, and assigns, jointly and
severally, firmly by these presents.....
Sealed with our seals and dated this.....day of....., A.D. 190 .
THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, That whereas the
said.....ha.. entered into a certain contract,
hereto attached, with.....Secretary of the
Treasury, acting for and in behalf of the United States, bearing date the
.....day of....., A.D. 190 : *Now*, if
the said.....
.....
shall well and truly fulfil all the covenants and conditions of said contract,

(2)

and shall perform all the undertakings therein stipulated by.....
to be performed, and shall well and truly comply with and fulfil the conditions of, and perform all of the work and furnish all the labor and materials required by, any and all changes in, or additions to, or omissions from, said contract which may hereafter be made, and shall perform all the undertakings stipulated by.....to be performed in any and all such changes in, or additions thereto, notice thereof to the said suret..... being hereby waived, and shall promptly make payment to all persons supplying.....labor or materials in the prosecution of the work contemplated by said contract, then this obligation to be void; otherwise, to remain in full force and virtue.....

IN TESTIMONY WHEREOF, The said.....

.....

....., principal , and.....

.....

and....., suret.....
have hereunto subscribed their hands and affixed their seals the day first above written.....

Signed, sealed, and delivered in presence of.....

Two witnesses to each signature. ..... [SEALS OF WAX OR WAFER.]

.....

.....

.....

NOTE.—It will be observed that on each page, both of form of contract and of bond, each type line is numbered, 1, 2, 3, etc. This is customary in all such government documents, and is for the purpose of locating references, interlineations, etc.

At first glance, this contract appears to be one-sided in that it confers on one side certain seemingly arbitrary power which, if used in the extreme, would be disastrous to any Contractor; but, as a matter of fact, the Department uses its extreme rights with the utmost caution, and generally goes more than "half-way" in disputed settlements.

Where disaster occurs—such, for instance, as in a cyclonic wind, wrecking work in place, as happened at the Pan-American Exposition; or in damage by fire, as in the Baltimore conflagration—the Department promptly recommends that Congress make a reimbursing appropriation to be used in replacing work damaged; and that body always responds, recognizing a moral if not a legal obligation.

RESIDENCE OF BENJAMIN ALLEN, WINNETKA, ILLINOIS
Marshall and Fox, Architects, Chicago, Illinois

THE ARCHITECT IN HIS LEGAL RELATIONS

CONTRACTS

Legal considerations often enter into the architect's work, and dictate his course of action. An architect in active practice cannot acquire such a knowledge of the principles of law as will enable him to dispense with expert advice in unusual circumstances, or in matters of great importance. The trained power of legal reasoning which, with an accumulated knowledge of law, is part of the equipment of a good lawyer, and which, even in apparently simple situations, is constantly called into use, is not to be attained by a man whose chief energy is given to another profession. Nevertheless, it is important for an architect to have some knowledge of the nature of legal considerations and of the legal principles of commonest application.

In the following pages will be found brief general statements of the law upon certain matters with which an architect is much concerned, and suggestions as to the application of these principles to his business. It should be mentioned that the laws in different states differ widely in details; it is impossible here to go into such details. What is given is intended to provide such an understanding of principles as will give the student a certain knowledge of the nature of his legal rights and duties, some conception of the kind of mistakes which are possible, and of precautions which may be taken, so as to constitute a practical safeguard in everyday business.

It is proposed to present first a general statement of legal principles affecting the relations into which an architect is brought in the practice of his profession.

LAW OF CONTRACTS

The building contract, commonly made between the owner and the builder, confers certain powers upon the architect. While

the architect is not a party to this contract, and so cannot enforce it, he is by reason of it drawn into the contractual relations of others. For this reason alone, the branch of the law dealing with contracts is an important one to him. Moreover, he may have occasion to supervise or assist in the making of contracts in behalf of the owner; while in the important matter of right to compensation, the architect is dependent upon the law relating thereto.

Express Contracts and Implied Contracts. When competent persons make a contract, their rights are fixed thereby. If, however, without any express contract, one person furnishes services or goods which another person accepts, and if there is no understanding that the transaction is a gift, the person furnishing the services or goods is not without a right to compensation. The law imposes upon the person receiving the benefit an obligation to make compensation to the person from whom he receives it. This obligation is sometimes said to arise under an implied contract, as if, in accepting the benefit, it is impliedly agreed to make recompense. This principle is of great importance and frequent application. It will be seen later that it is applied not only when there is no express contract, but also in some cases where an existing express contract for some reason cannot be enforced.

The principle above stated, that an express contract once made by competent parties fixes their rights, is fundamental. Suppose *A* sues *B* upon an implied contract for material furnished, claiming $100 as the value thereof. If the parties had an express contract for a smaller sum, *A* could not recover $100, even though that might be a reasonable price; or if there was an express contract which *A* had not substantially fulfilled, *A* could not, in general, recover at all, unless indeed it can be shown that, in spite of *A*'s failure to fulfill exactly the contract, *B* has accepted the material. In that case the facts might raise a new implied promise. But if *B* refused the material, no such promise could, of course, be implied. On the other hand, if *A* offered material in compliance with the contract, and *B* refused to receive it, *A* could hold *B* answerable for breach of the express contract although *B* received no benefit therefrom.

Quantum Meruit. The contract which is implied in law is always to pay the fair value of what has been received. The Latin words *quantum meruit*, meaning as much as it is worth, are therefore

used to describe an action based upon an implied contract. To recover in *quantum meruit* accordingly means to recover the reasonable value, to be determined in the course of the action, of whatever has been furnished. It has already been explained that where there exists a valid and enforceable contract, on which both parties have the right to insist, no recovery can be had in *quantum meruit* for labor and materials furnished under the contract. This does not mean that where a contract once existed concerning such work and labor, or goods or materials, or concerning a part of it, an action in *quantum meruit* will never lie. There are various circumstances under which this action will lie, in spite of such an express contract. It sometimes happens that a contract is so altered that it is no longer ascertainable and is therefore treated as not existing. In such a case an action on an implied contract can be maintained. If a partly performed contract is abandoned by the agreement of all the parties to it, an action in *quantum meruit* will lie for the work or materials already furnished only in case the contract is what is known as an *entire contract* as distinguished from a *divisible* or *apportionable contract.* An apportionable or divisible contract is one susceptible of division or apportionment because of having two or more parts not necessarily dependent upon each other and not intended to be so dependent; as, for instance, in the case of a contract for building several houses, where there is nothing in the contract itself or the circumstances to prevent singling out the part respecting a particular house, and treating it as distinct and complete of itself. Such a contract might be of such a nature that it would be obviously unfair to one party or the other thus to separate the parts, and to hold a party bound as to a portion without regard to the rest. A contract of this latter sort would be an entire contract, that is, a contract of which the terms, nature, and purposes indicate an intention that each of its material provisions shall be dependent on all the rest. If, then, the contract which is abandoned is a divisible contract, of which one or more complete divisions have been performed, the contract may be treated as governing those divisions and recovery may be had only under the contract. But if the contract be an entire contract, it would not be fair to hold the parties as bound in respect to a portion only, never contemplated as complete in itself. Their rights must therefore be settled

on the theory of implied contract, the party indebted being answerable in *quantum meruit* only.

When one party to a contract is ready and willing to perform, but is prevented from performing or from completing his performance by the act or fault of the other contracting party, the first party may recover on the contract, or he may elect to rescind the contract and recover in *quantum meruit* for the labor and materials employed. If the party prevented from performing elects to rescind the contract and sue in *quantum meruit*, the party at fault is required to pay whatever the real worth of the work and materials is proved to be, not, however, according to the general rule, giving compensation in excess of the contract price for the whole.

In an action in *quantum meruit* the architect's certificate is probably not necessary to recovery, although where the architect has pointed out defects in the work or material already employed, and the builder claims to have remedied them, it may be practically necessary for the builder to show the architect's certificate stating that the defects have been satisfactorily remedied.

Validity of Contract with Illegal Provisions. In general, a contract which violates statute law, or any principle of the common law or of public policy, cannot be enforced. This may be of importance to architects in connection with restrictive building laws. The mere fact that a contract may be, or has been, carried out in such a way as to involve forbidden acts, does not render it invalid; the rule is aimed at such contracts as necessarily involve the doing of something illegal. Similarly a contract which is intended to effect a civil wrong to a third person may under some circumstances be illegal. An illegal contract cannot be enforced, according to the general rule, even by one who performed his part of the bargain, although for services rendered under such a contract there might be some right of recovery by implied contract. This is one of the subjects of which it is impossible to give here more than the broadest principles; the point to be borne in mind is that in case of any contract involving legal wrongdoing, there is occasion for caution and for ascertaining legal rights under the peculiar circumstances of the case as they may arise.

Validity of Contract Provisions Opposed to Public Policy. As contracts which involve violation of statute or common law

cannot be enforced, so there are principles of public policy which no contract will be allowed to contravene. Thus clauses such as are common in building contracts, providing that any future disputes arising in the course of dealing between the parties shall be determined in some specified way by arbitration are not always effective to prevent the parties from resorting to law. The policy of the law will not permit courts of justice to be thus ousted from their jurisdiction.

But in spite of the lack of binding force in agreements intended to prevent a resort to the courts, there is a method in which a resort to referees or arbitrators for certain purposes may be enforced. A clause of a contract making it a condition precedent to recovery in court, that the quality of materials, the value of services, the amount of damage and the time of paying it, or other matters not going to the root of the action itself, shall be settled in a certain way, is valid, and will prevent the maintenance of an action until all possible steps have been taken to comply with it. Thus the provision of many building contracts that certain matters such as those just named, shall be referred to the architect, is valid. The further stipulation that the architect's decision of such matters shall be finally binding, is also generally held effective, in the absence of bad faith on the part of the architect. When a contract is thus drawn, the agreement of the parties rests their legal rights directly upon the decision of the persons named. No obligation under the contract therefor arises until the arbitrators decide a question, and they having decided it, resort may be had to the courts in order to enforce their decision. The courts are therefore not ousted from their jurisdiction.

Parties to Contract. *Individuals.* In order to have a good contract, the parties must be legally competent. As an infant is favored by the law, a person on coming of age may affirm or repudiate contracts while made under the disability of infancy, although the other party to such a contract is bound. It is furthermore unsafe to enter into a contract with a lunatic or a drunken person. A married woman was formerly unable to contract; in some states married women may now make valid contracts about their own property, while in many states the disability is entirely removed.

Corporations. It may also be mentioned here that where a private corporation is a party to a contract, a question may arise whether or not the making of a contract is within the powers of the corporation. To determine what these powers are, reference must be had to the charter or articles of incorporation, and, perhaps, to the statute law of the State which created the corporation. If a corporation was formed for the purpose of building and operating a railroad, there would be no doubt of its power to build a station. If, on the other hand, a corporation formed to carry on a drug business should propose to build a grain elevator, legal questions would arise.

In dealing with public or municipal corporations, questions of the extent of powers may also be raised. Questions of this sort are extremely varied, and may be either very simple or very difficult of solution. Where a corporation makes a contract beyond its powers, the contract may, so long as it remains unperformed on both sides, be rescinded by either. Yet if a person has made a contract with a corporation, a contract which is in fact, beyond its powers, but which he has had no reason to suppose is outside such powers, and if he has in part performed the contract, his rights are generally protected by the law. This does not, however, make such a situation anything but a very undesirable one, and care should therefore be used to obtain reasonable assurance that a contract is within the powers of a contracting corporation. Common knowledge of the standing and nature of the corporation may give such assurance; on the other hand, the matter may be so close to the line that nothing but an opinion of competent counsel will be sufficient.

Assuming that the parties concerned are capable of contracting, there are two elements essential to the validity of the ordinary contract which will be considered here; one is *mutual consent,* and the other, *consideration.*

Mutual Consent Essential. *Common Intention.* In order to have a valid contract, the parties must have, and must communicate, a common intention. "Their minds must meet" in expressed agreement. If this element is absent, there can be no binding contract. For instance, in an English case the plaintiff agreed to sell and the defendants to buy a certain quality of Surat cotton

to arrive by the ship "Peerless" from Bombay. The plaintiff offered cotton from a ship named "Peerless" from Bombay, but the defendants refused to accept it, and the plaintiff sued for damages for this alleged breach of contract. It was admitted that the defendants in using the term "Peerless" meant a different ship from that which the plaintiff had in mind, and in which the cotton actually arrived; it therefore appeared that there was no mutual consent to the same matter, and judgment was accordingly given for the defendants. On the other hand, the law looks to the expressions of the parties, and when their expressions necessarily indicate agreement, it does not permit them to say that they were not agreed.

Communication of Offer and Acceptance. Consent is manifested by offer and acceptance. It follows from what has been said that both the offer and the acceptance must be communicated, but each may be communicated by conduct as well as by words. Thus if *A* asks *X* to work for him for certain wages, *X* in simply doing the work may accept the offer, unless some other form of acceptance was prescribed. It is also clear that the acceptance must be absolute, and in exact accordance with the terms of the offer. If *A* makes one offer, and *X* answers that he will do something a little different from what *A* suggested, there is no contract. *X*'s reply may amount to a new offer, which *A* may subsequently accept. This principle will later be seen to be important in connection with an architect's submitting plans in response to a request for plans in competition.

Time Element. An offer may by its terms remain open for a certain length of time, as, for example, for two weeks or until the return mail; if no duration is specified, it can be accepted only within a reasonable time. What is a reasonable time depends upon the circumstances of each case. In an action of law, the question would be determined by the jury. An offer may be revoked at any time before acceptance; the revocation, however, must be communicated to the offeree. If *A* offers to furnish *X* with a cornice for a certain amount, *A* may, at any time before *X* has accepted the offer, effectively withdraw it by declaring to *X* his intention so to do. At the moment when a valid acceptance is made, the contract, if good in other respects, is complete, and both

parties are bound. Acceptance is therefore irrevocable without the consent of both parties.

As to the important question when acceptance becomes binding—it is stated as a general rule that the acceptance is made when the acceptor has done all he can to communicate his intention. Thus the mailing of a letter of acceptance properly stamped and addressed marks the making of a contract, and is irrevocable. Under this rule the delay or loss of the letter in the mail cannot delay or prevent the binding effect of the contract, so that it may happen that a person making an offer becomes bound without his knowledge. For this reason it is prudent to make it part of an offer that acceptance shall be only by letter *delivered* within a stated time at the office or into the hand of the person making the offer. Upon this point of acceptance by mail there has been some doubt about the law, and there are old decisions in one or two jurisdictions that there is no contract until the letter of acceptance is received. The rule about acceptance by telegram would probably be the same as that governing acceptance by letter. If, on the other hand, an acceptance was sent by an agent of the offeree, it would have to be delivered to be effective.

In this respect of the time of taking effect, the revocation of an offer—which is ineffective until communicated—differs from acceptance.

Consideration Essential. Any promise not under seal, requires what is called a consideration to render it legally a binding contract. If a promise is under seal, the formality of the seal is the mark of the contract, as is consideration in the case of contracts not under seal. A valuable consideration in the sense of the law is said to consist either in some right, interest, profit, or benefit accruing to one party, or in some forbearance, detriment, loss, or responsibility given, suffered, or undertaken by the other. The consideration must be of value in the eyes of the law, but the question of degree of value is of no importance; the slightest consideration, so long as the law recognizes it as valuable, will support the largest promise. Consequently, upon a mere promise by *A* to give *X* $100, no obligation arises, *A*'s promise being without consideration; but if *A* offers *X* $100 for some service, which *X* performs, the performance, however unimportant, is good consideration for the

promise. Another promise is also good consideration for a promise. *A* says to *X*, "I will give you $100 if you will agree to draw me plans for a house." If *X* agrees to draw the plans the contract is then complete, and *X*'s promise is consideration for *A*'s, just as *A*'s is consideration for *X*'s. It is well to note a difference between the two foregoing examples. If *A* says, "I will pay you for making plans", the offer can be accepted only by making the plans; until the offer is accepted, it can be revoked, and *A* is not bound. On the other hand, if *A* offers to pay a certain sum if *X* will agree to do the work, and *X* agrees, *A* is bound, and *X* is protected, from that time. The best protection it will be seen comes through the latter sort of contract, consisting in outstanding obligations on both sides. In the former case there is really no contract, but only an offer, until the time of acceptance by performance of one party.

Statute of Frauds. The statute of frauds, which in somewhat varying form exists generally throughout the States, requires certain contracts to be in writing, and signed by the party to be charged therewith. The more important of these contracts for present purposes may be classified as follows:

(1) Contracts to charge a person upon a special promise to answer for the debt, default, or misdoing of another—that is, contracts of guaranty.

(2) Contracts for the sale of lands or any interest in or concerning them.

(3) Contracts not to be performed within one year of the time of making.

(4) Contracts for the sale of goods, wares, and merchandise of value above a certain amount (generally fifty dollars).

In the latter case, however, a partial delivery of the goods, as a partial payment to bind the bargain, takes the place of writing.

Upon such contracts, except as stated as to contracts of sale, no action can be maintained unless the agreement or some memorandum or note thereof is in writing and signed by the party to be charged, or in his behalf by some person duly authorized thereto.

An architect may have connection with contracts of any of these sorts, and the law should be borne in mind. The only class which will be especially discussed here is that of contracts not to be performed within one year from the time of making. In general, the statute does not include agreements which are merely not likely to be performed, but has regard to such as according to a fair interpretation, and in view of existing circumstances, do not

admit of performance within a year from the time of making. If, for instance, there is no stipulation as to time, but performance depends upon some event which may occur within a year, the statute does not apply. But if it is the manifest intent of the parties that the contract shall not be executed within a year, the mere fact that it is physically possible for it to be completed sooner, makes no difference.

In case a contract of one of the sorts above enumerated is not in writing, a party may recover upon it, in spite of the statute, unless the other party takes advantage of the defense of the statute in his pleading in court. And where one party to a contract which is void under the statute, and which the other party refuses to carry out, has performed his part of the agreement without objection by the other party, he may recover compensation upon an implied contract, although the express contract is unenforceable. So if an architect renders services under an oral contract which is not to be performed within a year, and the other party refuses to pay for such services, the architect, while he cannot recover for breach of the express agreement, may recover the reasonable value of the services rendered, according to an implied contract. Moreover, in such a case the express contract can be given in evidence as tending to show the value of the services. Although the value so shown cannot be enforced, it is sometimes held that no more than the contract price can be recovered. This is one of the cases before referred to where the doctrine of implied contracts is of importance as furnishing a remedy to a party to an unenforceable express contract.

Contracts Involving Conditional Performance. Performance of a contract by one party may be made wholly or in part conditional upon performance by another. Thus a contract by which *A* promises to render certain services and *X* agrees to pay for them, may be so worded that *X* will not be called upon to pay unless *A* has performed the services, or, on the other hand, it may be so arranged that *A* will not be obliged to act unless he is paid in advance. So if it is provided in a contract that *X* is to pay for *A*'s services only if they are completed by a certain day, and *A* does not complete his services by that time, *A* cannot, unless *X* has lost the right to insist upon the condition, recover under the contract. His only ground

of recovery would be under an acceptance of the services by *X*, and a consequent implied contract.

Not only may such conditions be expressed, but they may also be implied by the law. It is therefore necessary for a party to a contract to consider carefully whether he has done everything which he is called upon to do, before he can maintain an action against the other party for the failure of that other party to perform his obligation under the contract. When, by the contract, performance by the one is expressly made conditional upon performance by the other, the case is clear; if no such conditions are expressed, the question arises whether any are implied. A court in construing a contract in this respect, as in others, will attempt to ascertain the intention of the parties, and if it appears to have been intended that the whole or a part of performance by one party was meant to be dependent upon some portion of the performance by the other party, then effect will be given to this intention by holding performance under the contract conditional according to the intention shown. Take for instance a contract for the sale of land: One party may agree to convey the land at a certain time, and the other to pay the purchase money at the same time, without expressly saying that either act shall be dependent upon the performance of the other. Yet, as the meaning is clear that the acts are in reality to be mutually dependent, neither party is called upon to perform unless the other party is ready, able, and willing to carry out his part; and, on the other hand, neither party can maintain an action for breach without showing himself to have been able, ready, and willing to perform on his side. The practical result of these principles is that when *B* breaks his contract with *A*, and *A* wishes to hold *B* liable for the breach, *A* must carefully consider whether he has done all on his part that is necessary to put *B* in the wrong. As questions of some nicety occur on these points, it is desirable to take advice of counsel in season to follow out any suggestions regarding such steps as a preliminary to a suit.

Construction of Contracts. Disputes often arise over the meaning of contracts after they are made and perhaps reduced to writing. This may come from careless drawing; it may be due to the necessity of applying the contract to new and unforeseen circumstances, or it may arise from a desire of one of the parties to a controversy to

strain every point in his own favor. When such disputes arise, it is an important matter for the parties to know how the proper construction is determined.

If the question of the construction of a contract is involved in a litigated case, the matter is determined by the judge, not by the jury. There are many rules of construction by which the judge is guided, only some of the more general and the more important of which will be mentioned here. While no oral evidence to explain or supplement a written contract will be heard, yet the judge may consider other distinct agreements of the parties which modify the contract in question. He will also hear evidence relative to the circumstances of the parties when the contract was made, as tending to show the meaning of expressions used. Oral evidence may also be given to show the technical, and sometimes the customary, meaning of words contained in the contract. When, however, a custom is relied upon to give a word a meaning different from that generally accepted, or to add to the substance of a contract, it must be a custom that is reasonable, certain, defined, and uniform. In most cases the custom must be proved to be known to both parties to the contract. It is important, in framing contracts, to employ words in general use, and to employ them in a commonly accepted sense, seeking clearness and precision, and carefully avoiding possible ambiguities. In construing a contract, the object of the court is to ascertain the real intent of the parties at the time of signing. The judge seeks to decide what meaning the words had as used by the parties, under the given circumstances, at the given time and place. In construing any portion, he takes the whole instrument into account, and looks for such an interpretation as will give effect to every part.

Assignability of Contracts. Contracts which involve personal services, where the element of individuality is important, cannot be assigned, and the estate of the person whose services are contracted for cannot be held to the contract. If, therefore, an architect dies, his contract for services is terminated. In general, however, a contract is assignable, and both the benefit and the burden of it pass to a man's estate. In case of bankruptcy of a contracting party, therefore, an ordinary contract passes to the assignee or trustee. It should be considered, in drawing a contract, whether it is desired

to include a provision making bankruptcy, or death, of one or either of the parties, terminate the contract.

Avoidance of Contract. A contract made between competent parties, and apparently having all the legal requisites of a good contract, may still, under certain circumstances, be set aside by the court. If in the formation of a contract there has been mistake, misrepresentation, fraud, duress, or undue influence, the injured party may, by proper legal proceedings, avoid the agreement. Such mistake as may be the basis of relief must not be mere careless mistake; it is in many cases of such a nature as almost to involve misrepresentation or fraud. Duress occurs where the consent of one party is obtained by violence. Undue influence implies that the will of one person is absolutely overcome by the will of another, so that the consent of the first is not really an independent act. Perhaps the most important of the above-named grounds of avoidance is fraud. In case a contract has been entered into upon a material and wilfully false representation by the other party, it may be avoided. Occasion for this may arise, for instance, upon deception in the purchase of materials.

Reformation of Contracts. Where a contract has been reduced to writing, but through a mistake, does not express the agreement of the parties, it may be reformed by a court so as to correspond with the real understanding. This is the more important because of the important principle that a party to a written contract is not permitted, in an action founded upon that contract, to show by evidence outside the writing itself, that the agreement was not what the written statement shows it to be. He may avoid the contract on one of the grounds stated in the preceding section, or he may show that another, later contract, whether oral or written, affects it, but he may not attempt to show by oral testimony that it was something different from the written expression. If the contract was in fact different from what is shown by the writing, and if the other party will not consent to the required change, application should be made to the proper tribunal for reformation.

Penalties and Liquidated Damages. If a contract provides that upon default by one party, that party shall pay to the other a certain sum, and if it appears that the payment is intended as a penalty and was inserted only for the purpose of securing performance,

it will not be enforced by the courts. If, on the other hand, it appears that the sum is named as a measure of compensation for a breach, it is called liquidated damages, and is valid, fixing the amount to be recovered if, by reason of a breach of contract, the provision comes into effect. Clauses of this nature are often introduced into building contracts.

The courts seek to ascertain the real intent of the parties in making the provision. The fact that the sum is specifically called liquidated damages is not conclusive; if the sum named is clearly disproportionate to the damage which would be suffered, it tends to indicate that a penalty was intended. Again, where the contract involves the doing of many acts of various sorts, and only one fixed sum is named to be paid upon a breach, a similar inference would be drawn. Conversely, if the sum varies with the extent of the breach, as where a certain amount is to be paid for each day of delay, it is an indication of an intention to fix liquidated damages.

If the damages in case of breach would be readily ascertainable, it is more likely that a named sum will be held to be a penalty than in cases where it would be very difficult to determine the actual damage. The attempt to impose penalties being one to which the courts will not give effect, and the validity of such clauses depending largely upon their reasonableness, it is obvious that no general rule for drawing liquidated damage clauses can be given. Because of the complexity of the matter, contractors often have very erroneous ideas on the subject; having learned of some one test sometimes applied by the courts, they are likely to believe such test conclusive. The necessity of care in drawing these clauses is increased by the fact that where there is doubt, the courts incline to treat the amount fixed in the contract as a penalty rather than as liquidated damages. It is important that the amount stipulated as a measure of damages for the breach mentioned be clearly reasonable.

Breach of Contract Operating as Discharge. If one party to a contract is guilty of a serious breach thereof, the other party may thereupon have the right to treat the contract as terminated. The test is whether the breach goes, as is said, to the "essence of the contract". No rule can be laid down as a guide to show what breach does go to the essence. The contract must be construed and the intention of the parties ascertained. It is well to remember,

however, this possibility—that very grave deviation by a builder, for instance, from the requirements of a contract, might, at the choice of the owner, discharge the contract. Furthermore, it is to be noted that if in any contract some matter is of especial importance, which in other similar contracts might be of little account—as, for instance, the time of performance—its importance should be made clear. In such a case it is desirable to state expressly that the matter in question is of the essence of the contract, although this language in itself would not be held conclusive. If the importance of a certain provision is made clear, then, in case of breach in respect of that matter, the injured person will stand in a better position, and be safe in holding himself discharged from further obligation to proceed under the contract. In case of the termination of a contract, however, it must be remembered that if the party terminating it retains the benefit of work already performed by the other party, the first party will be liable to pay for such work, under an implied contract.

Discharge by Consent. It hardly needs to be said that a contract may at any time be discharged by all the parties thereto. It is desirable to have the discharge, like the contract, clearly made in writing so as to cover all questions of further rights and liabilities.

Waiver of Rights. If a party to a contract clearly waives his right under a certain clause, and the other party, relying on such a waiver, does not fulfil that clause, the resulting variation from the contract terms is excused. Thus, if a building contract makes an architect's certificate a condition precedent to payment, and if the owner gives the contractor to understand that the certificate will not be required, this waiver renders the production of the certificate unnecessary as a condition of payment. Waiver may be found in the conduct, as well as in the words, of a party. The question whether words or conduct amounts to a waiver, is one for a jury to decide.

Modification of Contracts. Contracts may always be modified by agreement of the parties. The subsequent agreement must be a good contract according to the ordinary rules, in order to effect a change in an existing contract. A waiver may also practically modify a contract. It is important, however, for the sake of avoiding complications and disputes, to have a contract always kept

clear and readily provable. Hence it is only a reasonable precaution to have any modifications of a written contract put in writing. One advantage of this is that the written expression of the understanding is likely to be made more definite, thus avoiding disputes on the ground of inexactness, as well as on the ground of misunderstanding.

Suretyship. The relation of suretyship arises where, besides an obligee, as, for instance a creditor, and the principal obligor, as a debtor, there is another person who becomes answerable for the debt or default of the principal obligor, and who is called a surety.

The contract of a surety is so peculiar as to form the subject of a separate branch of law. It will be remembered that this contract is one of those which, under the *Statute of Frauds*, must be in writing, in order to be enforceable. The principle of the law of suretyship chiefly to be noticed is that, if the creditor acts in such a manner as might affect the position of the surety and increase his liability, the surety is discharged. Therefore, if in a contract between *A* and *B*, *C* becomes surety for performance of *B*'s part *A* must proceed with great caution in all matters affecting his relation with *B*. In some states, if the surety requests the creditor to bring suit against the debtor, and the creditor refuses to do so, the surety will be discharged. Written requests to sue are provided for by law in some States. Lack of diligence in prosecuting a suit may forfeit the creditor's right against the surety. The release of one surety discharges co-sureties from so much of the original debt as the person discharged could have been compelled to pay. Therefore, if the property of the debtor is held for security, and is surrendered, the creditor loses his claim against the surety to the extent of the value of the property. The point chiefly to be regarded as most likely to affect building contracts is that any material alteration in the contract between the creditor and the principal which would extend the liability of the surety beyond the terms of his original agreement, and to which the surety does not assent, discharges the surety.

LAW OF AGENCY

An architect may be empowered, and act, as agent of the owner. Aside from this possibility, the law of agency is so much

involved in business transactions, that it is highly desirable to understand in some degree the principles of that branch of the law. The general principle of agency is that a person acting through another is as much bound as if he acted directly, without such an instrument.

Agent or Independent Contractor. Not every person employed by another to accomplish an object, is an agent. The relation of agency implies control of the agent by the principal. A person may be employed to do certain things in such a way as to leave him independent, so far as any such authority of his employer is concerned, and bound to his employer only by such definite agreements as exist between them. Thus it has been held that a person employed under a certain contract to build a house for another, was not an agent, but was an independent contractor; and it is probable that the contractor under the ordinary building contract would be so held. An important result of this would be that the owner would not be liable for acts and neglect of the contractor in the way in which it will appear a principal is liable for acts and neglect of his agent.

Powers of Agent. So long as an agent acts within the scope of his authority, he binds his principal thereby. The authority of an agent may be expressly granted or impliedly granted. If persons dealing with an agent know him to be acting under a written power of attorney, they are bound to inquire and take notice of the nature and scope of the power, and fail to do so at their own risk. If the expression of the authority has excluded a certain power persons dealing with the agent are held to know that such is the fact, and cannot, therefore, hold the principal bound by the action of his agent in excess of the power granted. But the agent may, and usually does, have powers outside of such as are expressed. These are called implied powers. The extent of such implied powers is oftentimes a difficult question of law. Such powers are to be implied only from facts from which is inferred the intention of the principal to grant them. It is said that every delegation of power carries with it, as implied powers, authority to do all things reasonably necessary and proper to carry into effect the main power conferred, and not forbidden by the principal. Moreover, a widely known and long existing usage which is reasonable and not con-

trary to law, may have the effect of conferring power upon an agent in addition to that expressly granted. It is also to be noted that although an act of an agent exceeds his authority, the principal may subsequently ratify the act so as to make it binding upon himself as if authorized in the first instance.

Liability of Principal. Not only is a principal liable upon such contractual obligations as may be entered into by his agent acting in his behalf within the scope of the granted authority, but the principal is also liable for such torts, or civil wrongs, such as trespass, assault, or battery, which his agent may commit in the course of his business.[1] This often proves a serious matter to employers, although the development of liability insurance has furnished a means of equalizing the risks. This shows further the importance of the question whether a person is an agent or an independent contractor. If he be the former, then the principal as well as the agent himself, is liable for torts. If the latter, there is no way of going back of the individual wrongdoing.

Duties of Agent to Principal. The first duty of an agent is the strict and far-reaching one of loyalty to his trust. In enforcing this the law looks not at the intent or effect in any given transaction, but at the tendency of such transaction in general, and at the policy of permitting a given course of dealing. Thus it is a general rule that an agent may not deal in the business of the agency for his own benefit, but that all the profits made in the business of the agency belong to the principal. A decision in accordance with this rule held that where one person employed another for hire to pursue and capture a horse thief, the principal was entitled to a reward offered for the capture effected by the agent. While an architect in the ordinary course of his professional duties does not act exclusively as agent of the building owner, yet in matters where he is not acting as arbiter between the owner and the contractor he is in general held to a duty of loyalty to his employer which is substantially that of an agent. Thus it sometimes occurs that dealers offer rebates to architects specifying their wares; such rebates undoubtedly belong to the owners, the owner being entitled to singleness of purpose in his interest on the part of the architect, and the latter being under obligation to obtain supplies at the lowest possible price and give his employer the

full benefit thereof. The operation of the rule of agency is not defeated by a custom to the contrary, nor is an agent allowed to accomplish by indirect means what would not be permitted if done openly and directly.

Another duty of the agent is to obey instructions, and the agent is liable for losses incurred by his disobedience. While the necessity of a sudden emergency may be a justification for the agent, in the use of sound discretion, in departing from his instructions without consulting his principal, on ordinary occasions an agent makes material and unauthorized departures from his original instructions at his peril. It is further the duty of every agent "to bring to the performance of his undertaking, and to exercise in such performance, that degree of skill, care, and diligence which the nature of the undertaking and the time, place, and circumstances of the performance justly and reasonably demand. A failure to do this, whereby the principal suffers loss or injury, constitutes negligence for which the agent is responsible".* The law holds an agent to the exercise of such care and skill as persons of common capacity engaged in the same business may be supposed to possess. In the case of an architect the law would presume, in the absence of anything to the contrary, that in giving his services, he warranted himself to possess in a reasonable degree, the knowledge and skill required for the work undertaken.

Delegation of Powers by Agent. The principal is entitled to the personal knowledge and skill of his chosen agent, and the agent may not, unless specially authorized, delegate to others the powers conferred upon him by his principal. But in the case of duties of the agent which are merely mechanical or ministerial, involving no elements of judgment, discretion, or personal skill, power to delegate is implied. So the nature of the duty may be such as to require reliance upon others in performing it; and the authority of an agent will be so construed as to include the necessary and usual means of execution, so long as such means are not prohibited by express instructions.

Undisclosed Principal. When an agent, in dealing with a third party, does not disclose the name of his principal, the third party is at liberty, on finding out who the principal is, to choose

*Mechem on Agency, p. 329.

between holding him responsible, or holding the agent himself personally bound by the transaction. Consequently an agent, for his own protection, should not only state that he represents another person, and is not binding himself, but should make it clear just who his principal is. Thus if an architect be employed to purchase material or to contract for labor, he ought to state that he acts only in behalf of the owner, whose name he should give. The proper form of signature where an agent acts for his principal is "*A* (name of principal), by his attorney, *B* (name of agent)".

Questions of Agency in Connection with Corporations, Societies, and Public Officers. In dealing with a body of persons, incorporated or unincorporated, it is important for an architect to know whether his employment is authorized, so that he may look to some satisfactory source for his compensation. It has already been stated that in dealing with corporations it is prudent to ascertain whether the proposed action is within the powers of the corporation. It is further to be noted that a corporation can act only through agents, and that questions will therefore arise as to the powers of the agent, who will usually be an officer of the corporation. Thus in entering into a contract with a corporation, one should have evidence of the powers of the representative of the corporation with whom he deals. The power would generally appear in the by-laws or in some vote of the stockholders or directors. Many powers connected with routine business are conferred upon officers merely by virtue of their office, the by-laws investing them with "the duties usually incident to" the office in question. In important matters depending upon votes, it is to be considered whether the proceedings are formally correct, a matter upon which expert advice may be necessary. Oftentimes business houses or social or religious societies have names which might indicate them to be corporations, while in fact they are not incorporated. The law does not recognize as an entity or unit any firm or unincorporated association, but regards such bodies as merely collections of individuals, although statutes in some states permit suit to be brought against even an unincorporated society as a body. Aside from these statutes, in suing a club or an unincorporated society the persons composing it must be named individually, and the legal remedy is against such members as are liable; whereas in the case of a corporation, it is

sued as a legal person. In the latter case the liability of stockholders is limited; but a member of an unincorporated club or society who is bound by a contract made for the society may be liable to the full extent of the contract. No general rule can be laid down, however, that all members are liable for acts of a society. The question arises whether each member has given authority to bind him by the given action, a question often of great difficulty. Thus an architect who supposes himself to be acting for a club or religious society, may find himself in case of dispute with a claim against only the members of a small committee which authorized the work.

In dealing with public officials, the limits of their authority are to be ascertained from the general laws, or from the charter of the particular municipality. A public body, in order to have its acts valid, must be acting as a body at a meeting properly held and organized. The agreement of all the members of such a body outside of a meeting does not constitute official action.

MISCELLANEOUS MATTERS

Law and Equity. Our courts give relief of two classes, according as they sit as courts of law or courts of equity. Equitable powers were formerly exercised by separate courts; but now the higher courts generally have both legal and equitable jurisdiction. A court of law as such is limited in its method of relief. Except in some cases in which the return of a specific chattel will be directed, and in actions concerning the title to real estate, a court of law can compel the payment of damages only. A court exercising equitable powers, on the other hand, may order a defendant to act, or not to act, in a certain way; the penalty for failure to comply with such an order is punishment for contempt. Injunctions present a familiar instance of an equitable remedy, enforceable by contempt proceedings.

One of the important classes of equitable actions is found in bills for the specific performance of a contract. Instead of submitting to a breach of contract, and recovering money damages therefor, the aggrieved party may in many, but not in all cases, by means of a bill in equity, compel the other party to perform the contract. Thus in the case of contracts for the sale of land, equity will take jurisdiction; in that of contracts for the sale of

personal property, equitable relief is not ordinarily given. Equity will not in general grant specific performance of a contract involving the exercise of discretion and skill and the rendering of personal services, and would undoubtedly refuse to compel an architect to carry out an agreement to perform the services commonly rendered in the designing and building of a house. The reason is found in the impossibility of judicial supervision of the work. The remedy for such a refusal by an architect would be by an action for damages. A building agreement would not ordinarily be enforced in equity, although certain agreements involving simple construction have been enforced. A negative promise, as, if an architect promises not to work for any person in a certain locality other than *A*, or not to erect a building similar to *X*'s, may be enforced by injunction.

The reforming of contracts, hitherto referred to, is also a matter within the powers of a court of equity only.

Resort to Legal Proceedings. In regard to resort to the courts it is to be borne in mind that it is necessary not only to have a just case, but also to prove it. This proof may be before a jury if either side so chooses, and a little reflection will show the element of uncertainty which is thus introduced into any litigated dispute. Moreover the matter of proving one's case is much affected by the rules of evidence, rules sometimes arbitrary in their nature, and largely the result of practical considerations involved in the use of the jury system. From these it may result that matters which have some weight in ordinary discussion, are not allowed to reach the ears of a jury. Thus hearsay, or what one person knows only by the word of another, is generally excluded, although it might have a certain limited value as proof. Another practical consideration in a question of bringing suit arises in the difference in the laws of different states. It may happen that a person's chances of success in a suit depend upon the place where his action may be brought. The delay necessarily incident to legal proceedings, a delay especially trying in the large cities, is also to be considered. From these few considerations alone it appears that the question of advisability of bringing suit, or of peaceful compromise, may be a complicated one. On the other hand, by no means every suit that is begun is settled by trial in court. A lawsuit may be an excellent means of bringing an obstinate or grasping person to reason.

Liens. A lien is a claim or hold upon the property of another as security for a debt or claim. Statutes in many states give so-called mechanics' liens upon land and buildings to various persons who have done work in constructing or repairing the latter, although it be only a contractor, and not the landowner, who is liable upon the contract. In a few states these statutes have been held to extend to architects; while in some other states it has been held that architects are not entitled to liens for services under these statutes.

These laws are of importance to owners inasmuch as they render their property liable for the debts of the contractors, since an unpaid workman, hired by the contractor, can secure his wages through his lien on the building. It is therefore common in building contracts to guard against loss on this score by a provision that the last payment shall be made only after the lapse of a certain time after the completion of the work. The period named corresponds with the limit of time for claiming liens. Workmen and subcontractors are usually very familiar with the law in the details in which it immediately affects their rights, and commonly conduct themselves in their work, in cases in which trouble is anticipated, with a view to helping their legal remedies. Thus it will be found that subcontractors very frequently prolong their work on one pretext and another, in the hope of extending the time within which liens may be secured. The legal means necessary to establish these liens cannot be stated here. The services of a lawyer are necessary, as in instituting any other legal proceeding.

Bankruptcy and Insolvency. The statute law provides a method by which a person can, by giving up all his property and otherwise fulfilling the terms of the law, escape further liability upon ordinary debts. State laws upon this subject are called Insolvency Acts, and are all superseded by an Act of Congress on the subject, the latter being known as a Bankruptcy Act. At present a Bankruptcy Act is in effect. An adjudication of bankruptcy or insolvency may take place upon the petition of a debtor or of his creditors, and thereafter all the property of the debtor is vested by order of court or otherwise in some person appointed by the court usually called an assignee or trustee. By this transfer of property any assignable contract would pass to such trustee or assignee. If the contract is not assignable, it would not pass, but in that case

the original contractor, stripped of property and of credit, is not a desirable person with whom to continue relations. For these reasons it is well, as has already been said, to introduce a clause into building contracts that the insolvency or bankruptcy of the builder or owner shall release the other party from further performance.

One who is a creditor of an insolvent has to prove his claim before the court in a formal manner. If one has a large claim against such a person, it is sometimes best to secure counsel, as fraudulent practices, intended to deprive creditors of their dues, are not uncommon.

Knowledge of the Statute Law. A practicing architect should familiarize himself with such laws of the state, and such ordinances of the town or city in which he is employed as especially apply to his work. These laws and ordinances may concern him in many ways. It may be that such laws will require a license for the practice of an architect's profession; and they probably will impose building restrictions with which it is important for him to be familiar. He should know what, if any, privilege of inspection is vested in any persons by force of the law, and he should understand the requirements about building permits and other similar matters. It is sometimes provided that public contracts shall be awarded only after competition, and certain notice given, so that if the requirements are not complied with, such a contract will not be valid. In many places the building laws will be found to be collected and printed together; inquiry at a city hall for such a compilation is advisable. In other places it may be necessary to seek out the laws on these matters from general compilations. It is a familiar maxim that ignorance of the law is no excuse for breach of it. Moreover it will be seen later that a person employing an architect has a right to rely on the architect's knowledge of building regulations; so that the latter will be liable to his employer if through his ignorance the laws are infringed and the employer suffers. Service in the office of an architect of established practice has the advantage that many points of information of this sort, which it may be difficult to obtain elsewhere, become familiar to the student.

Torts. Torts are a large class of wrongs arising, not in a breach of a contractual duty owed by one person to another, but in the breach of a duty which the law imposes upon one member

of society for the benefit of others. Thus a man owes a duty to use due care to avoid injury to any one of his fellows with whom he is brought into contact. The commoner torts are familiar to everyone—trespass, assault, battery, and actions for negligence. A few not so commonly understood may be mentioned here.

If *A* makes to *B* a statement knowing it to be false, and intending to lead *B* to act upon it, and *B* does act upon it to his damage, *A* is liable. This is called deceit. It is not uncommon that such statements are made to induce a person to enter into some relation or contract. The fraud may then, as has been seen, afford ground for treating the contract as void; it may also give rise to an action for deceit.

The law imposes various duties upon landowners to keep their premises in safe condition for persons using it in the regular course of business. The duty need not be considered here further than to say that if an architect so designs a building as to render it dangerous to persons in the uses contemplated for it, he may cause the owner to be liable for ensuing damage. For this loss to the owner it will be seen later the architect might be legally responsible.

There is one liability of an extraordinary sort which may occasionally affect a landlord. Ordinarily if a man's use of his land causes damages to another the landowner is liable only if his negligence contributed to the damage. But if a man builds a peculiarly dangerous structure on his land, then he may be liable for any damage it causes, although he is guilty of no negligence, and although the damage would not have occurred but for some natural catastrophe, as a flood or a tornado. So a man building a reservoir on his land has been held liable for damage caused by its bursting in time of flood; and the doctrine might be extended to cover a variety of unusual or essentially dangerous structures, thus necessitating extraordinary care in construction.

It has already been said that for torts of an agent committed in the course of his employment, the principal, as well as the agent himself, is liable.

ARCHITECT'S DUTIES IN GENERAL

The first part of an architect's duty in any given employment is ordinarily the drawing of plans. In this work he acts substan-

tially as another person of skill might act in another capacity—a lawyer in drawing a will, or a physician in treating a case. It is sometimes said he is at this stage the agent of the owner; but in the typical case no questions of agency are practically involved, and it is doubtful if the architect may be considered at this stage in any other position than that of an independent contractor.

The plans being completed and accepted, the architect often acts for his employer in getting bids. At this time he may be invested with powers as agent of the owner. But this can be only by express agreement, and the architect should be extremely careful not to make any representations or arrangements in which he may seem to act for the owner unless there is unquestionable authority to bind the latter. Otherwise, as has been seen, the architect may make himself personally liable. Where the architect has no power as agent, but is concerned in assisting his employer, without having power to bind him, it may be well for the architect to state expressly that he has no authority to bind the owner, and that his inquiries or suggestions are made only for the purpose of submitting the results. At this stage, then, an architect may, by special arrangement be agent of the owner, or there may be no agency involved, or an agency so narrow, in the mere advertising for bids, or receiving offers, as to present no questions of importance.

When the contract between the owner and the builder, called the "building contract", has been made, the architect has certain powers and duties under that contract. Of course the owner may invest the architect at this stage also with various powers as his agent. Such powers, depending upon the agreement in each case, cannot be profitably discussed here. The general observations on the subject of agency will apply. But as to the powers and duties of the architect under the building contract, the position of the architect is now so substantially similar in large numbers of cases, that the matter may well be considered. With "The Uniform Contract"; and "The Standard Documents"* as well as the other information in connection with them herein referred to, it will be well for the student to become familiar.

*These papers are printed in the Appendix.

ARCHITECT'S POSITION UNDER THE BUILDING CONTRACT

Whatever powers the architect has, under the building contract, which is a contract between the owner and the contractor, are not powers which he himself can enforce. The parties to that contract have not, by virtue thereof, bound themselves to him. They have made mutual promises, and have given to the acts of the architect, as between themselves, a certain force. By virtue of this agreement either party to it may hold the other to this provision giving effect to the architect's action. But the architect himself cannot insist upon having that effect given to his acts. In a sense, it may be said that he has rights, but, legally speaking, has no rights under the contract. Whatever contractual rights he has as against the owner or contractor must be by virtue of some contract to which he is a party. And whatever similar rights the other parties have against him must be by virtue of some contract to which he is a party. To illustrate—the building contract usually provides for inspection by the architect. Should the contractor refuse to permit this inspection, the refusal would be a breach of his contractual duty to the owner; but the architect himself would have no legal cause of complaint against the contractor, for the contractor's promise in regard to inspection was made, not to the architect, but to the owner; the only legal cause for complaint would therefore be in the owner. Bearing this in mind, what, merely as between the owner and contractor, are the duties and powers with which the architect is invested by the building contract?

Certificates. It is commonly provided in the building contract that payments for work shall be conditional upon the giving of certificates by the architect. Such a provision in an ordinary contract applies to extras as well as to the specified work, since extras are contemplated and provided for in the contract. Inasmuch as the giving of the certificate demands an exercise of judgment on the part of the person giving it, such certificate should be given only by the party named to give it—by the architect himself—and on his own knowledge of the facts; unless, indeed, there is an express provision in the contract authorizing him to delegate this duty to another. Where there is such a provision for delega-

tion a certificate by the party to whom the duty has been delegated is, of course, valid.

Similarly the certificate of the architect must be strictly in the form provided for in the contract. If the contract does not provide that the certificate shall be in writing there is no rule of law precluding a certificate by word of mouth. Were there space within the limits of this article, many decisions might be cited holding certificates sufficient or insufficient under the contracts applying to the respective cases. The following will suffice to show what sort of question arises:

In an Illinois case (Barney *v.* Giles, 120 Ill. 154) the building contract provided that payment in full should be made "on the presentation of the architect's certificate certifying that the contract has been and truly performed, and accepted by him, and that all damages or allowances which should be paid or made by the parties of the second part, have been deducted from the amount of the said final certificate". A certificate was given, the substantial part of which was as follows:

"This is to certify that Barney & Rodatz, contractors for the mason work of your additional stores, are entitled to a payment of $1,079.73, by the terms of contract.

"Remarks—Work has been measured at building".

It was held that this certificate was insufficient because it did not state that there were no claims for damages; and that the mere fact that no claims had been presented did not remedy the defect.

Where the architect certifies to the work at its different stages, i.e., gives interim certificates, he should be very careful not to overestimate the work done, because if he does overestimate, and the contractor abandons his contract, the owner will be left in the position of having paid more for the finished portion of the work than it was worth, and the architect may find himself personally liable for the amount in excess of what he should have certified to.

The architect's final certificate is the document in accordance with which the accounts are closed, and should be made up very carefully. It should be given only after all the work is done, the extras noted, and, if allowed, a reasonable price fixed therefor. The architect should at this time be informed of all variations or all omissions in the performance of the contract, and the rights

of the owner in respect to such are to be carefully protected. If the variations are of a serious nature, the owner may not be obliged to accept or pay for the work. On the other hand, the owner may take the work as it stands, but demand and, if necessary, recover at law, damages for the deviations from the contract. Where the contract is not exactly carried out, the architect should ordinarily refuse a final certificate. In some cases it may be proper for him to give a certificate stating all omissions or variations from the contract, and reserving to the owner all rights on account thereof. This latter course might be called for by the terms of a particular contract, or it might be rendered proper by agreement of the parties. Where a conditional certificate of this sort is given, it may not be such a certificate as is required by the contract as a condition precedent to payment; for, as shown above, where a certificate of certain form is called for, a certificate in materially different form is not sufficient.

When an architect's certificate is made a condition precedent to payment, what is the position of the contractor if it is refused? If it is refused for good cause, of course, the contractor cannot recover the payment in question. If, on the other hand, the contractor has faithfully performed his part of the contract, and can show that a certificate was refused through the fraud of the owner, then the failure to produce a certificate will be excused, and the contractor may recover in spite of it. Between those cases where the refusal is justified and those where it is fraudulent are the cases where the refusal is neither justified nor fraudulent, but unreasonable. It is often stated that where the refusal is unreasonable as well as where it is collusive or fraudulent, the contractor may recover without the certificate, after proving, of course, the unreasonable character of the refusal. Such is the law in some states. On the other hand, it is argued that the agreement of the parties gives effect to the granting or refusal of a certificate by the architect chosen, and that it changes the agreement to undo the effect of his decision merely because to a judge or to a jury that decision appears unreasonable. It has accordingly been held in some jurisdictions that nothing short of fraud will excuse the nonproduction of the certificate. The authorities are not uniform on the question whether fraud by the architect alone excuses

non-production of the certificate or whether fraud is an excuse only if the owner participates in it.

The contract may provide that the work shall be done to the satisfaction of the architect, and that his certificates shall be given only when he is satisfied with the work. The effect given to such a contract is different in different jurisdictions. The point of difference is whether the contractor is bound to satisfy the peculiar tests and opinions of the architect specified, or whether such work as would satisfy a reasonable man in the architect's position would be sufficient, so that any refusal of a certificate under these circumstances would be regarded as merely whimsical and unreasonable, and sufficient in some jurisdictions not to prevent the contractor's recovery.

The contractor may also recover payment without producing the certificate which was made a condition precedent, if the owner has waived his right to insist upon the condition. A California case held that where a building had been completed and occupied apparently without objection from the architect or owner, although no certificates had been given, the occupancy was evidence that the owners waived the requirement of a certificate and payment was due on the contract. In a Wisconsin case it was held that payment of 50 per cent of the price without demanding the certificate was a waiver of the certificate as to that part and also as to the other part, unless notice had been given that the certificate would be required for the remainder of the work. Of course each of these cases was determined on the special circumstances under which it arose. It is certain that occupancy alone does not necessarily constitute a waiver of the condition as to the certificate. The question of waiver of this condition is subject to the ordinary considerations of the law upon that subject.

It is generally held that if by the death of the architect it becomes impossible to procure the certificate the non-production will not prevent recovery by the contractor.

The next question that arises is as to the effect of the certificate when once given. It is not finally binding on the parties in such a manner that its findings cannot be contradicted, unless the provisions of the contract render the certificate of binding effect. As the certificate depends on the contract for its effect it can have

force only to the extent therein provided for, and a certificate pretending to settle matters not left to the architect's decision is ineffective as to such matters.

Even after a certificate has been given which according to contract is finally binding on the parties, it may be impeached on various grounds so as not to bind the owner to pay for the work certified to. Fraud or mistake are generally grounds for avoiding it. The wilful disregard by the architect of his duty has been held a ground for avoiding the certificate; as has the concealment of defects by the builder, and collusion between the contractor and one of the parties. As to just what facts constitute a ground for disregarding the certificate, the law differs in the different states. The law in some states is that if an architect gives a certificate for work which subsequently shows imperfections which have been concealed from the architect and which he could not have discovered by the use of reasonable care in inspection, such certificate does not waive such imperfections, and the owner need not pay the full contract or certificate price for such work. The law in other states, on the other hand, is that nothing short of fraud or collusion between the contractor and the architect will excuse the owner from payment according to the certificate. Some states even go so far as to say that even fraud will not excuse the owner. In such cases, however, the owner would have a claim against the architect for his loss. Of course each case depends on the wording of the contract. Where under the contract the certificate is merely an expression of the architect's opinion that the work is in compliance with the provisions of the contract, such certificate cannot be conclusive evidence of the performance of the contract. The question can arise only under contracts which provide that each party shall be bound by the certificate. Where on any ground the certificate can be disregarded, the owner is enabled to make a claim for defects or omissions which would be excluded were he bound by the certificate. The fact that the work certified to is not entirely completed, or that the architect has estimated the work done pursuant to the contract as less than the work actually done, or made a mere mistake or error in judgment, does not constitute fraud vitiating the certificate, or raise a valid ground for impeachment. There may therefore be negligence on the part of the architect in giving

a certificate which would give rise to a right of action against him on the part of the owner, but which would not affect the binding nature of the certificate; for the architect would be responsible to his employer for his failure to use care and skill in giving the certificate as in other parts of his work.

To resume the subjects last treated: The architect's certificate has, as between owner and contractor, whatever force is assigned to it by their contract; if they have made it merely a condition precedent to payment, then it is important only to entitle the contractor to recover, and he may even recover without it under certain circumstances varying in different jurisdictions; the certificate would have no further effect in binding the parties, and would be only *prima facie* evidence of the facts stated in it; it could be contradicted by the owner, if for instance he claimed damages for defects the existence of which was inconsistent with the certificate. If, however, the parties have agreed to be bound by the certificate, then the owner could not recover in such a case unless he was prepared to show that there were grounds for disregarding the certificate, as above stated.

A question might arise as to an architect's power to withdraw or to alter a certificate once given. If there were such cause as would furnish ground for disregarding the certificate, such as a fraudulent concealment from the architect, clearly he should be at liberty to withdraw it. Should the architect, however, attempt to withdraw or alter a certificate merely to correct his own mistake, and should the contractor refuse to submit to the desired change, the architect would be put in an awkward position. The certificate given would be sufficient under the contract to fix the rights of the parties, and there would be no ground for setting it aside. For his own negligence he would be answerable to the owner; but there seems to be no ground on which he could insist on a return of the certificate.

Where the certificate is based on measurements, as is frequently the case with interim certificates, it would seem that the contractor has a right to be notified and to be present at the taking of such measurements even though it is not expressly provided for in the contract. As the courts are not unanimous upon the question of the necessity of such notice, it would be well, although

not in all cases legally obligatory, for the architect, whenever he knows there is or may be a misunderstanding between the parties, to give them opportunity to be heard before his decision.

As to the signing of certificates where a firm of architects are employed, the signature of a certificate should of course be in the firm name. Whether one partner has power to sign is an ordinary question of the law of agency as applied to the subject of partnership. It would seem that a partner who had charge of the work undoubtedly has such authority. If the various members of the firm have participated in the work it would of course be only prudent that all should be consulted and expressly authorize the issuance of the certificate.

The subject of the architect's liability to the contractor for unjustly refusing to give a certificate is treated under the heading "Liability".

Settlement of Disputes. As already shown, an agreement between owner and contractor that the architect's certificate shall be conclusive between them is binding, and under such an agreement the architect's certificate can be disregarded only on certain grounds. The building agreement may in like manner give binding effect to the architect's determination of various matters, and such agreement may be binding upon the parties. In connection with such agreements, however, the legal principles before stated in connection with arbitration clauses (under the heading "Legality of Contract") are important. Under the law as there stated, general provisions for arbitration of disputed points are not binding. The proper way of drawing these clauses for the settlement of disputed matters is to make the decision of the architect a condition precedent to any action upon a disputed point. The decision of the architect may then be made conclusive upon both parties, and in accordance with the intention of the parties will be enforced by a court.

Wherever the architect acts as referee to determine matters in dispute he should of course act with impartial justice toward the parties. As he is employed and paid by the owner, and as his functions under the building contract are largely for the purpose of protecting the owner's interest, it may be somewhat difficult for him to take an unbiased attitude. His position is in fact anomal-

ous. Engaged and paid by the owner, often with a personal interest to keep the cost within fixed limits, looking chiefly after the interests of the owner, for whom he may be for some purposes the agent, he is nevertheless called upon to weigh certain matters with a fair and undiscriminating regard for the rights both of the owner and of another person having directly opposite interests. Yet the reference of disputed points to him assumes that he will take such an impartial attitude, and the binding force of his decision would be destroyed if it could be shown that he had decided a question not with judicial impartiality, but as a partisan. It may therefore be said that in his function of adjusting disputes, the architect acts in a quasi-judicial capacity.

Inspection. The ordinary contract provides that the contractor shall furnish proper facilities for inspection by the architect, and shall replace materials and take down work condemned by the architect as unsound, improper, or failing to conform to the contract. The architect is under obligations to the owner to use reasonable diligence to see that the materials used and the work done conform to the plans and specifications, and will be liable for damage caused by failure to use such diligence. Nevertheless the matter of inspection is so related to other functions of the architect, such as the granting of certificates, and the settlement of disputed points, that it seems the architect must, in many cases at least, act in a quasi-judicial capacity, rather than as agent for the owner, in making inspections.

The architect should require the contractor to pull down and to do over any work visibly not in accordance with the plans and specifications. The exact means by which the architect may make his inspection are not defined. In one case it was held that the architect might properly drill enough holes in metal columns reasonably to satisfy himself they were of the required thickness. Of course any method of inspection which substantially injured or weakened the work would not under ordinary circumstances be permissible. Where parts of the work are concealed before the architect has had an opportunity to inspect them, assuming that the architect was properly performing his duty of inspecting and that such concealment when made was a necessary part of the contractor's work, it would seem that the architect could have the

covered part removed so that he might inspect the interior. If this interior should prove to be made of poorer material or by poorer workmanship than called for by the contract, the architect might order it removed and replaced correctly, and the cost of the tearing down for inspection, the removal, and the replacing should all be paid for by the contractor. But if the interior proved to be according to the contract, it would seem that the owner should pay the cost of the tearing down and rebuilding, and that allowance for any delay caused thereby should be made to the contractor. But when the architect delays or is remiss in his inspection or in making objections to the work or material, and in consequence thereof parts of the work or material are concealed without any wrong intent on the part of the contractor, but in the ordinary course of the work, then it would seem that the architect should bear the expense of removing the concealing parts even when the concealed parts are not in accordance with the plans and specifications. Again, it seems that if the contractor concealed part of his work for the purpose of avoiding inspection of it, and such concealment was in no way due to wrongful delay in inspection by the architect, then the contractor should pay the cost of tearing down, removing, and replacing the concealing parts, even though the interior proved to be in accordance with the plans and specifications. In short, the builder must give the architect a reasonable opportunity to inspect the work and materials, and the architect on his part must use his right of inspection within a reasonable time and in a reasonable manner.

In view of the above observations it is desirable to insert in the contract a provision that the inspection of work which cannot be examined properly during the architect's ordinary visits of supervision, shall be made at the expense of the contractor on the demand of the architect.

Other Powers Under the Building Contract. Wherever any act of the architect has by the building contract been given a certain force as regards owner and builder, the architect must be careful to make his action exactly like that described in the contract in order that the agreed force may attach to it. Whatever authority or power is given the architect is strictly construed by the courts; that is, the architect must exercise his authority or

power strictly in the manner provided therefor in the contract, and if he exercises it in any other manner, it is not binding on the other parties. For example, an architect who may, by the contract, give written orders for extras or for variations from the contract, has no authority to give oral orders, and the owner will not be bound by any such oral orders. What constitutes a written order for variations from the contract is often a very difficult question to determine. Some courts hold that detailed plans are written orders for variations from the contract as represented by general plans, while other courts hold that they are not written orders within the meaning of the contract. This is often an important matter, because if there is a variance between the general and detailed plans, and the builder constructs according to the detailed plans, the contract having been made to construct according to the general drawings or plans, and the architect having authority to order variations by written orders only, then the builder cannot recover the contract price unless such detailed plans are considered as constituting written orders within the meaning of the contract.

Relation of the Architect to the Owner. An architect, like any other professional man, impliedly contracts with his employer that he has the ordinary skill, knowledge, and judgment possessed by men of his profession, and that he will use this skill, care, and judgment in the interest of his employer, and will act with perfect honesty. If legal damage arises from defects in the plans or specifications which are the result of failure to exercise the required skill, knowledge, or judgment, the architect is liable to the owner for such damage. In a general way it may be said that this knowledge and skill required includes the knowledge and skill necessary to planning buildings or parts of buildings such as those planned by the architect, a knowledge of the qualities and strength of materials used in such buildings, the weight of the structures, the relationship of the various operations to be performed by the many trades represented in building, and a knowledge of all other matters directly related to drawing plans and specifications.

In addition to this knowledge of the fundamental laws of nature, of materials, etc., an architect represents himself as possessed of a knowledge of the statutes, ordinances, and laws relating to buildings and to the erection of buildings at the place where the

structure is to be located. It would seem, however, that he would not be charged with knowledge of the decisions of inspectors or referees in regard to points left indefinite by the statutes, ordinances, or building laws of the particular locality, unless such decisions are in the court or public records. The architect is likewise liable for his failure to use reasonable skill, etc., in any respect in which he acts as agent for the owner. In an action to enforce such liability what constitutes reasonable care, skill, and judgment is a question of fact for the jury to determine. Unless it is specifically provided otherwise, the architect who undertakes to superintend a building is bound not only to furnish proper plans, but to see that the structure is at least reasonably well constructed, that the foundations are sufficiently deep and otherwise protected to prevent settling or cracking of the walls, that the contractors do not put in defective workmanship or materials, or make material variations from the plans and specifications, such as a competent architect using the requisite care, skill, and attention would detect and prevent, or detect in time to have remedied. Where the architect has the duty merely of furnishing plans and specifications, such plans and specifications must be reasonably accurate and suitable. The architect does not guarantee that his work is perfect or that the building will be a success, he merely contracts that they will be as nearly perfect and successful as the average competent architect would make them.

The architect is held, in respect to loyalty to his employer, to the rules applicable to an agent. The impropriety of his having any secret financial interest in the work has been spoken of under the general laws of agency.

Inasmuch as the contract with the architect is for personal service demanding skill and judgment, the contract does not survive the architect but is terminated by his death. Therefore his executors and administrators are not liable for the failure to fulfill the contract caused by the architect's death.

Inasmuch as the architect performs a personal service, one demanding the exercise of special skill, judgment, and discretion, he cannot, in the absence of special authority, delegate the performance of such services to another because of the rule of law already stated. As this rule does not apply to the purely minis-

terial duties of an architect, such as measuring or drafting, these latter duties may be delegated even in the absence of express authority.

Architect as Agent for the Owner. The architect should be extremely careful that he has authority from the owner before assuming to bind him in any way. It is desirable to have such authority express and definite. In important matters, or with unreliable clients, written authority should be obtained. The mere fact that the building contract provides for some action by the architect as agent of the owner, may be evidence of authority from the owner to the architect to take such action on the owner's behalf, but is not conclusive evidence of such authority. In other words, if the action of the architect which is contemplated by the contract is action as agent of the owner, then the architect needs authority from the owner before taking such action, and the provision of the contract may not be enough to show such authority to have been granted. If, however, the action of the architect contemplated by the building contract is action in a quasi-judicial capacity, no authority from the owner is necessary to empower the architect to take such action. His action then derives its force not from the authority of the owner but directly from the contract itself. It is sometimes difficult, as has already been seen, to tell in just what capacity the architect acts in a given function, and considerable caution is necessary on his part not to assume an authority as agent which has not been granted, and so render himself liable without so intending. To illustrate a function of the architect often provided for by the contract, but requiring authority by the owner, we may take the matter of ordering extras or alterations, where such ordering is provided for by the contract between owner and contractor.

For the purpose of showing the ordinary limits of the architect's powers, attention is called to certain acts for which he is not empowered. In the absence of special authority, the architect has no authority to modify the building contract or alter plans or specifications, to extend the time for completion, to change the original contract, to bind his employer for extra work, to accept an inferior class of work, to waive an agreement by the owner as to the terms of payment, to excuse the contractor from any of the provisions of

the contract, to employ another to do the work which the contractor has undertaken, to substitute another for the original contractor in the performance of the work or the payment therefor, to supervise the letting of sub-contracts and the employment of workmen, or to consider, in making up his statement of the accounts between the owner and architect, any accounts outstanding in other matters between the parties. The architect cannot, without express authority, bind the owner to pay for work or materials. He is not the owner's agent for the purpose of receiving notice of an assignment of payments due from the owner.

Where the architect is for any purpose the agent of the owner, there will, according to the general rule of agency, be various implied powers necessary to carry out the purposes of the agency. The extent of these will vary with the facts of each case. If the architect acts as superintendent of construction, the powers may be quite extensive. As circumstances may enlarge an agent's powers, an architect might in an emergency be authorized to take extraordinary steps for the protection of the owner's rights or property.

In general, it may be repeated, the architect should be careful not to exceed his powers, and wherever practicable should have his authority definitely stated in writing. One regard in which architects sometimes exceed their powers may be especially mentioned; that of incurring unnecessary expense for artistic reasons. Although an architect may have authority in a given case to bind the owner in ordering necessary materials, furnishings, or extras, he is not necessarily justified in increasing the expense therefor, on grounds of taste.

Contractor's Relation to the Architect. By the ordinary building contract, the contractor enters into obligations with the owner only. To the architect, who is not a party to the contract, the contractor owes no contractual duties which the architect may enforce in law or in equity. However, by the contract it may become the builder's duty to the owner to obey the architect's instructions, to do the work to his satisfaction, and the like. These duties of the builder can be enforced only by the owner. Therefore, according to the rights of the owner, the architect may be said to be entitled to obedience as provided in the contract.

Architect's Duty Toward the Contractor. Although the architect is employed by the owner he must act fairly and honestly toward the contractor. This of course precludes any attempt to overreach the contractor, or any secret arrangement with the owner to deprive the contractor of any money justly due him.

Thus an architect has been held liable to the builder for damages sustained by him by reason of a fraudulent refusal to issue the certificate made essential by the contract. The architect who acts as a superintendent or arbitrator is supposed to act as an impartial man of science. Where it is shown that the architect is personally interested in favoring the owner at the expense of the builder, or *vice versa*, as where the architect guaranteed or merely assured the owner that the whole cost of building would be below a certain sum, it has been held that his awards should be set aside if they are unjust, in spite of the agreement that his decision shall be final and conclusive on all parties.

It is the architect's duty to interpret his plans and specifications when such interpretation is requested by the contractor.

Discrepancy in Plans. It sometimes happens that the details in the plans do not agree with the specifications prepared by the architect to go with the plans, or the small-scale drawings do not agree with the detail drawings. When this occurs it is necessary to determine which—the plans or specifications, the small-scale drawings, or the detail drawings—shall prevail. This question arises most frequently after work has been performed according to the plans or specifications, the small-scale drawings or the detail drawings, and the other side claims the work does not conform to the provisions of the contract, relying on conflicting provisions elsewhere. Then it becomes necessary to determine which is controlling. Where there is a discrepancy between the drawings and specifications, or between the small-scale drawings and the detail drawings, there is some conflict as to what the order of preference should be. The more general rule, however, is that specifications take precedence over drawings and detail drawings over small-scale drawings. This rule must of course give way where in any contract the provisions indicate a contrary intention. Where there is a discrepancy between two sets of drawings of equal importance it seems well settled that the contractor is bound only by that set

which he has seen and on which he has based his estimates. Where the discrepancy is between two different clauses in the specifications the facts of the case control; the question is decided by common sense rather than by technical reasoning.

The greatest care should be taken to avoid such questions.

Limit of Cost. Where nothing is said about fences, terraces, grounds, or other unusual items, the limit of cost given the architect will be supposed to cover only the bare cost of the building, usually without screens, or outside windows, or any grading or planting beyond the smoothing of the ground within six or seven feet of the building, and the removal of the surplus gravel, dirt, or clay from the excavations to some convenient part of the premises. The architect's fees and the expense of superintending the building are not regarded as a part of the estimated cost. It is, however, far safer here as elsewhere to have a distinct understanding between the owner and the architect.

Any estimate by the architect of the cost can be approximate only, because the cost depends on so many matters which are beyond the knowledge of the architect; for example, combinations of local mechanics, monopolies, approaching bankruptcy of the builder, etc. In view of these uncertainties it is considered unreasonable to hold the architect to a strict compliance with the owner's wishes in regard to cost, and the owner has no right to dismiss the architect because the contractor's bid is higher than the limit of cost given, unless such bid is greatly in excess of the limit. In the event of a moderate excess it is common for the architect to aid the owner in modifying the plans so as to come within the limit without making any extra charges for such aid. As to what is a reasonable or unreasonable excess of the limit fixed there is no established rule. The courts are rather lenient to the architect in this matter.

There are two ways of providing for an excess of the estimate over the limit given. One is to provide by agreement before the work is begun that the plans may be returned to the architect and no payment made if the contractor's estimate is more than 25 per cent in excess of the limit. The other way is to make it a condition precedent to acceptance of the plans that the contractor's price shall not be above a certain amount. It is strongly recommended that one of these methods should be adopted.

Liability of the Architect. It has already been stated that an architect impliedly represents himself to be possessed of the skill and knowledge possessed by the average architect in that locality. If in fact he does not posses such skill and knowledge, and loss results to his employer because of the lack of such skill and judgment, the architect is liable to his employer for such loss. For a similar reason and in a similar way the architect is liable for damage resulting from his failure to use care, diligence, and judgment in the performance of his duties. The mere fact, however, that the plans, structure, or work are not absolutely accurate or successful does not make the architect liable to the owner for damage resulting therefrom, for the architect does not guarantee absolute accuracy, perfection, or success. It is only when such inaccuracy or failure is caused by the failure on the part of the architect to have and to exercise the skill, knowledge, or judgment he represents himself as having, that the architect is liable. The damage for which the architect may become liable by reason of his failure to possess or to use the usual skill, etc., may be for the increased cost of the building due to remedying his mistakes, or it may be for damage directly caused by the defects in other ways. The fact that the owner was present while the work was being performed does not excuse any neglect on the part of the architect. The owner has a right to rely on the architect's professional knowledge and skill; and if he is so negligent as to allow a building or a part of it to be constructed in a dangerous or doubtful manner, he is not excused from the liability incurred by such neglect by the fact that such construction was permitted at the request of the owner. Only a valid specific agreement between the architect and the owner to the effect that the owner would hold the architect excused from any liability to him arising from such dangerous or doubtful construction, would relieve the architect of liability to the owner. It is needless to remark that such an agreement would be an extremely dangerous one for an owner to make.

Where an architect undertakes to superintend construction he is liable to the owner for any damage resulting from material variation from the plans and specifications, on the part of the contractor, from poor construction, or from the use of poor material, if an architect using the ordinary care and skill usually bestowed by

architects acting in such a capacity, would have prevented the improper work, or detected it in time to have it remedied. Under this rule an architect is held not to be liable for all the minor details of the work, as in one case for the failure of the builder to mortise joints with pegs where the joints were in the roof of the porch.

Where an architect acts as superintendent of construction, he is not, of course, liable for loss arising solely from the negligence or incapacity of the contractor, unless the architect is himself in fault, for he would be answerable for the fault of another only on the ground of agency, and the contractor is not the architect's agent. Wherever the duties of an architect are enlarged by a special agency in any case, he is liable for failure of skill, care, or fidelity in such enlarged duties. The fact that the contractor also is liable for damages resulting from poor construction does not relieve the architect from liability arising from his own neglect, nor does it necessarily give the architect the right to reimbursement from the contractor. They may both be liable for the full amount of the damage, and the owner may elect whether to sue the architect or the contractor or both together.

If the architect on his own responsibility, without authority from the owner or without claiming to act as his agent, orders extra work, he is personally liable for such work.

If an architect is negligent in his duties, and as a result an accident occurs in a building after completion, by which some stranger suffers damage, the architect would probably never be held liable to the stranger. The architect's sole legal duty in the premises seems to be toward the owner, to whom only he is liable for failure to do proper work.

On the other hand, an architect may in the course of his work come under legal duties to others than the contractor and owner, the breach of which may render him legally liable. For instance, an architect, having general charge and direction of the work, adopted a method of construction which did not provide adequate support, a defect which resulted in injury to a workman, and the architect was held liable to the injured man. The distinction between the cases is that in making plans for a building the architect is in effect an independent contractor whose sole duty is to his employer. In the latter case, however, the architect was acting as

the owner's agent in superintending construction, and as agent was charged with his principal's duty to provide safe ways and works for those engaged in the construction. It would extend this article too far to consider all the duties which the owner may owe to third parties, and which, in special cases where the architect acts as agent for the owner, may affect the architect himself. Suffice it to say that where one undertakes to act as agent it is incumbent upon him to act with regard to the rights of third parties against his principal in the premises. The express direction of his principal will not excuse the agent for so acting in his agency as to cause legal injury to third parties.

A word should be added under this heading about the possibility of liability for the acts of others. Where some assistant causes damage by his negligence or wrongdoing, if he can be shown to be the agent of the architect, the latter is liable, according to the general rule of agency.

It has been held that an architect is liable to the contractor if the architect fraudulently refuses to give a certificate to the contractor. But a refusal to grant a certificate where one is due, which arises only from a lack of care or skill, does not render the architect liable to the contractor. If the architect's fraud is in collusion with the owner, then both may be sued together by the contractor, or either may be sued separately.

Public Officials. An architect, acting as a public official as, for instance, city architect, will, of course, be in a different position from an architect in private practice. An architect employed in a public capacity for a regular salary is probably not liable for lack of skill or care. It would be beyond the scope of this article to consider in any detail the positions into which, as a public officer, an architect might come. Upon undertaking such work, a man will, of course, consider the nature and responsibilities of the office.

Competitive Designs. When a person, a public body, or a corporation advertises inviting architects to send in competitive designs, all designs sent in should conform exactly to the terms of the invitation sent out. If this is not done the design submitted is not entitled to consideration. The common form of advertisement for designs, and the submission of designs conforming with the terms of the advertisement, do not constitute a contract. The

advertisement is merely a request for offers. The submission of the design is an offer, and becomes binding only on acceptance by the party advertising. Although it seems that this party is not bound to accept the design representing the lowest bid, it is very desirable for the sake of clearness, to put into the advertisement a clause reserving the right to reject any or all designs submitted. Of course where the advertisement is for bids for public work, if a statute or city ordinance required that the work be awarded to the lowest bidder, then the party making the lowest bid may enforce his right to the award. A request for plans is, of course, unlikely to come within such a statute. An invitation to compete may, however, be made in such a manner as to constitute an offer, and give some one of the competitors a right to hold the persons making the offer bound by a contract. For this purpose, as has already been shown, the plans must exactly correspond with all terms of the offer.

Ownership of Plans. In the absence of any agreement as to the ownership of plans, it is impossible to make any general statement as to the law on that point. Whether the property in the plans passes to the employer, or whether, on the analogy of notes made by other professional men, such as physicians and lawyers, the property in the plans remains in the architect, the right to the use and possession during the construction being in the builder, is a question to be answered only upon examination of the law in each jurisdiction. The tendency of the lower courts of the different states seems to be toward the former view. It is however said to be the almost universal custom in England and the United States for the architect to retain the plans after the completion of the structure. And it is now customary to insert in the building contract a stipulation that plans shall remain the property of the architect. While this is evidence of the agreement with the architect to the same effect, it would seem desirable that this agreement be expressly made between the two persons interested, the owner and the architect.

However doubtful the actual ownership of the architect's plans may be, it is clear that until they are published, as it is called, that is, given out by the architect so that anyone may see them, no one except his client has the right to copy, reproduce, or otherwise

use them, without the architect's permission. This right of the architect not to have his plans used without his permission ceases after publication. Whether plans have been published is a question to be decided on the facts of each case, but it is clear that by selling the plans outright the architect loses all right not to have them used. Where plans are submitted to competition for a cash prize, it has been held that the plans awarded prizes become the property of the party inviting the competition. Whether or not an architect's plans or drawings of a building may be copyrighted is an open question.

Compensation. The architect's legal right to compensation is, of course, a contract right, either under an express contract, if one exists, or under an implied contract. If an express contract fixes the rate of compensation, of course the architect's rights are fixed by that. If there is an express contract which does not fix the amount of compensation, or if there is no express contract covering the employment, the architect's right is to charge as much as his services are reasonably worth. While from a legal point of view it would be wiser to have the rate of compensation settled by the binding agreement of the parties, it is probable that in most cases of the employment of an architect, the matter of his fees is not expressly agreed upon, and in case of dispute the architect would be left to receive under the implied contract what his services are fairly worth. One reason for this practice is the existence of a customary schedule of charges, which architects are accustomed to demand and to receive for their services. This schedule* is framed by the American Institute of Architects. The influence of this schedule on the question of compensation is an important one.

In the first place, it is obvious that rules made by a body of architects cannot, as such, bind persons employing the architects. These schedule rates may, however, be of some importance in either one of two ways. In the first place, it may be that the payment of these schedule rates is a custom which must be taken to have been in the minds of both parties, and binding upon them as a part of their contract. Custom may be thus brought to bear for the purpose of proving a term of contract, provided always that the contract does not expressly contradict the custom.

*See Appendix II.

Such a custom must, however, be reasonable; and courts have been of opinion that schedules similar to this in question were not, as they applied to various cases, reasonable. Moreover, the custom must be proved to have been known to both parties to be affected, either by actual knowledge being shown on their parts, or by its being shown to be so general in the locality that the inference is irresistible that both knew it. It is greatly to the advantage of an architect whose compensation has not been fixed by agreement, to be able to hold his employer to this schedule, and therefore important to bring notice of the schedule home to the employer. For this purpose the schedule is sometimes printed on an office letterhead, and several of these letterheads used in early correspondence before work on plans actually begins. From a lawyer's standpoint this is but a makeshift to take the place of the definite understanding which should be reached.

Even if the schedule is not admissible in evidence as showing a customary term which is to be read into the agreement between architect and owner, it may be admissible merely to show what is reasonable compensation. This is obviously quite a different matter from proving it to be a binding clause in the contract. Other evidence can be heard to contradict that furnished by the schedule, and the result in a litigated case would be doubtful.

Unless it is clearly understood that the plans and specifications are to be submitted subject to approval, an owner by contracting with an architect for plans and specifications and by receiving them makes himself liable to pay the architect whether he uses the plans and specifications or not. Where, however, it is understood at the outset that the plans and specifications are made conditional on the approval of the owner, if they do not meet with his approval, the architect cannot recover for them. It would seem, however, that the owner should give the architect a reasonable opportunity to alter the plans and specifications so as to meet his wishes. It has been held that after rejecting and returning the plans several times, the owner is at liberty to procure plans elsewhere.

Practical Suggestions. Before drawing plans, an architect should inspect the proposed site, and determine the nature of the soil. If the building is to be on old foundations, he should observe these foundations and determine their strength, and if the work

consists of alterations, he should examine the existing structure for weaknesses or peculiarities which would affect the proposed work. If important, he should ascertain the character of the subsoil, and he should inform himself of the location and grades of existing sewers if any are to be used. He should also note any adjoining buildings, and the effect they may have upon the site in question. He should inquire of the owner about any easements, or rights in the owner's land, which other persons may have, such as rights of way, and about any party-wall agreement affecting the premises. It frequently happens that in a conveyance of land, restrictions upon the use of the land are imposed; for instance, as to the height, setback, character, cost, or the like, of buildings to be erected. While the architect is not expected to have the title examined in order to see what, if any, restrictions exist, it may frequently be prudent for him to make special inquiry of the owner as to the situation in this respect.

The plans when completed should (1) conform with the instructions given the architect, (2) comply with all laws which may be applicable, (3) not infringe the rights of any third person, so far as the architect is informed of them, and (4) be in accordance with all rules of the architect's science and art. It must be remembered that the employer's mere approval will not be an excuse for faults of which the employer is not a competent judge.

Care should be taken to keep written records of important matters. With regard to agreements, the advantages of having them in writing are obvious. While a contract by word of mouth is (aside from the Statute of Frauds or other provisions of law) as valid as a contract in writing, the latter has the advantage of precision, affording a means of showing with certainty what the contract was. An oral agreement is more liable to differences in interpretation, and there is the added danger of faulty recollection by the parties. A dishonest person may be checked by the knowledge that his agreement is in writing; while even a well-meaning person, when his memory of the transaction is not clear, may be considerably affected by his interest. In matters other than agreements, it is often important to have a written record; for example, if a party to a contract waives the doing of an act, such as the obtaining of the architect's certificate before the payment is made, the

question may arise whether the waiver is only for the particular occasion, or for all similar occasions under the contract. It is only by having the waiver expressly limited in a writing, a copy of which is available to the writer for purposes of proof, that security against such a claim can be had. It may also be desirable to have important instructions or notations in writing. Where there has been an oral transaction, of which a written record is desired, a letter stating and confirming the substance of the interview as the writer understands it may be promptly sent to the other party, who should at once disaffirm it if he finds it incorrect.

When a contract is put in writing, it is important to remember that while it may be afterward amended by the parties by a new agreement, it cannot be altered by evidence of any previous or contemporaneous oral agreement. The writing ought therefore to state exactly the agreement of the parties, as no understanding contrary to the written terms will be effective.

All business letters received, together with copies of letters sent, should be systematically preserved. Where proof of the receipt of any letter is desired, registration furnishes a convenient method. If the envelope is marked "receipt required", a receipt will be returned which can be filed with the copy of the letter. Such a receipt may save trouble in important matters; for instance, it might be supposed to be safe to deliver an acceptance of an offer to the person who had delivered the offer for the offeror, but if the acceptance is given to this person and not delivered by him to the offeror, there is or is not a contract, according to whether or not the person to whom the acceptance is given is or is not authorized by the offeror to receive it for him. While in most states the mailing of an acceptance is sufficient, yet the possession of a receipt from the offeror is obviously desirable.

In business transactions, it is well to be constantly on guard against possible misunderstandings or disputes. At any time, the interests of the parties may change through unexpected circumstances, and hence unforeseen claims and controversies may arise; an owner or a contractor may become bankrupt or die, and his interest will then be represented by another person, who may take an attitude toward past transactions which will be influenced by changed circumstances or by lack of knowledge possessed by the

original party. The more clearly business dealings can then be shown by written evidence, the less chance there is for trouble and litigation. The habit of keeping written evidence of important matters tends to discourage looseness and vagueness in dealings, and to promote the habit of guarding against misunderstandings.

Enough has been said to show that in regard to the agreement between the architect and his employer as to compensation, and as to powers which the architect is to exercise as the owner's agent, it is best to have a clear understanding in all respects. If the architect is to act as the agent of the owner in making the building contract, his powers in the way of accepting or rejecting offers should be clearly understood between the owner and the architect. In advertising for bids, the right should be reserved to reject any or all offers. It is, of course, desirable whenever the architect is acting as agent for the owner in important matters not in the ordinary routine, and not involving merely the exercise of the architect's professional discretion, to have the owner's specific written instructions, so as to avoid any claim that he has exceeded his authority or disregarded directions.

It frequently happens that the drawing of the contract between the owner and the contractor is left to the architect. Of the forms already referred to, and given in the Appendix, the Uniform Contract has been in common use. More recently prepared are the forms worked out by the American Institute of Architects, and called the Standard Documents. These include a short form of contract for signature by the parties, this paper referring to the contract and incorporating certain elaborate general conditions intended to include those conditions which experience has shown to be desirable. These general conditions are the product of much study and experience, and have been prepared with great care. The study of all these forms will be found helpful and suggestive. Many architects have developed clauses of their own for insertion in the building contract, and it is well for an architect to make notes on forms passing under his notice and on his experience with the various clauses of building contracts.

The Standard Documents appear to have various advantages over the Uniform Contract. If, for the sake of brevity, the Uniform Contract, or the general form thereof, is used, it will be well to run

over the general conditions of the Standard Documents and consider some additions therefrom adapted to the particular case; and also to consider some changes in the Uniform Contract. It has been decided in Massachusetts that under the Uniform Contract the final certificate of the architect made in good faith is conclusive. Accordingly, after a final certificate that the work is completed in accordance with the contract, the owner can not have an allowance for omissions or for defective work which should have prevented the giving of the certificate. In this same jurisdiction, however, the architect doubtless could have withdrawn or corrected his certificate within a reasonable time. This decision makes it apparent that it would be for the interest of the owner that Article 10 of the Uniform Contract should be altered to read: "No payment or certificate whatever shall be considered an acceptance of defective work or improper materials". The Standard Documents of the American Institute of Architects have a provision to the effect that the final certificate shall not relieve the contractor of responsibility for faulty materials or workmanship. The Uniform Contract may also be supplemented, with advantage to the owner, by a provision to the effect that before giving a final certificate, the architect may require evidence satisfactory to the owner that the premises are free from liens. The form of such provisions would be dependent upon the statutes as to liens in the jurisdiction. The Standard Documents have a provision in regard to this matter. In this connection the architect should avoid the responsibility of deciding that there are no liens. The determination of this fact might involve passing upon questions of law, as well as an investigation of matters of fact, which would make a substantial addition to the architect's work.

In putting agreements into form there is, of course, room for the exercise of much judgment and experience, and it is impossible to give any directions here beyond those which are suggested in various parts of the article. In general, it is important in drawing a contract, to consider carefully whether the words are so clear as to admit of only one interpretation. Clearness is best secured by making one carefully drawn statement of a point rather than by repetition in various forms of statement. It is to be considered whether general or specific words will best serve a purpose. By

providing that a contractor shall furnish safe appliances, the owner's interest will generally be better served than by specifying the kind of appliances to be used. If the kind of appliance were specified, then the risk of its safety would be transferred to the owner. On the other hand, where the object is to prescribe a certain material, that material should be so specifically described that no other will come within the description. The meaning of the language used must be carefully considered in the light of any trade usages. Not only is a man held to the natural meaning of his words, even if he has used them inadvisedly, but he may be bound by a knowledge of things which he ought to know, as by a custom so general in some branch of business that everyone is expected to know it. In drawing a contract one should be careful to specify just what, in the way of papers, plans, and drawings, goes to make up the contract, and to identify and to refer accurately to such papers. The provisions for interim payments should be so arranged as to assure the owner's having always a sufficient margin between the amount paid to the contractor and the value of materials and labor furnished, as a protection in case of difficulties which may result in an unexpected increase of expense in completing the work.

Building operations are sometimes carried on under a very different arrangement from that established by the Uniform Contract or the Standard Documents. For instance, instead of a contractor in the ordinary sense, a person could be employed to purchase supplies and hire labor as the agent of the owner, receiving a salary or a lump sum for the work, and always subject to the owner's orders in every respect. Such an arrangement would render the owner liable as principal for the negligence of his agent. While the owner might insure against this risk, it would generally be better to have the builder an independent contractor, whose compensation might be the cost of the building plus a certain percentage thereof. The importance to the owner of this distinction between independent contractor and agent is a sufficient indication of the responsibility assumed by the architect in undertaking the work of counsel and drawing contracts where established forms are departed from.

If the architect acts for the owner in making the building contract, he should use great caution, not only in choosing a contractor but also in his dealing with the successful and the unsuccessful

bidders, to avoid legal complications. Having first made it clear, by reserving the right to reject any or all offers, or otherwise that he is merely asking for offers, and not himself making an offer to be accepted by the lowest bidder, it may be well to make his acceptance of the chosen offer conditional in some way according to the circumstances. The acceptance may, for instance, be upon condition that a satisfactory contract be executed within a certain time, and provision may also be made for a bond with sureties, to be furnished by the contractor for the fulfillment of the contract. It is, of course, unfair to ask for bids from contractors with whom the owner would be unwilling to make a contract. In acting for municipal corporations, there are frequently peculiar statutory or other requirements to be observed in the making or drawing of the contract, which, however, will ordinarily be attended to by municipal officers.

If an architect is called upon to take the place of another architect under an existing building contract, the former will, in the absence of any clause in the contract permitting the substitution of an architect other than the one therein named, have no standing with the contractor unless the contractor agrees to the substitution. One of the general conditions of the Standard Documents provides for this situation.

During the progress of the work, it is necessary for the protection of both parties that the premises should be insured. Otherwise if the contract is an entire contract, and if the work should be destroyed, the contractor would be unable to recover compensation for the portion damaged, while the owner may be unable to recover what he has already paid. The Uniform Contract provides for insurance by the owner in the names of the owner and the contractor, while the Standard Documents provide for insurance by the owner for the benefit of whom it may concern.

During the progress of the work, care must be taken in making changes in the contract to safeguard the interests of the parties, and to leave the contract in ascertainable and proper shape. If the contractor is excused from a portion of the work, it should be clearly understood that an allowance is to be made therefor. If the allowance can be fixed at the time, a source of possible future dispute will be avoided. Changes in the contract should be made

in writing, if not in the form of a contract, at least in letters expressing the agreement of both parties. The common saying that "silence gives consent", if relied upon, may be productive of difficulties.

An architect should have a regular system of bookkeeping which will enable him at any time to show how much labor of his own and of his office force has gone into any matter. Difficulties over fees cannot be foreseen, and the office system should provide for such contingencies by furnishing all the material needed for recovery on a *quantum meruit* if necessary.

Whether or not an architect has a lien for his services, either in drawing plans or in superintendence, depends upon the statute law of the State.

APPENDIX

NOTICE TO ARCHITECTS, BUILDERS, AND CONTRACTORS

The Standard Contract Forms may be obtained singly or in lots from dealers in stationery and architects' supplies. If your dealer cannot supply you, send your order and his name to the Secretary, A. I. A., The Octagon, Washington, D. C.

PRICES FOR SINGLE COPIES

Agreement and General Conditions in cover	$0.10
Bond of Suretyship	.02
Form of Subcontract	.02
Letter of Acceptance of Subcontractor's Proposal	.01
Complete set in cover	.15

Trial set delivered upon receipt of nine 2-cent stamps.

DISCOUNTS TO ARCHITECTS, BUILDERS, AND CONTRACTORS

Orders for quantities are subject to the following discounts (which are also given by all dealers):

5% on lots of 100 (1 kind or assorted)
10% on lots of 500 (1 kind or assorted)
15% on lots of 1,000 (1 kind or assorted)

THE STANDARD DOCUMENTS OF THE AMERICAN INSTITUTE OF ARCHITECTS

Second Edition, Copyright, 1915, by The American Institute of Architects, The Octagon, Washington, D. C.

The American Institute of Architects issues the following Standard Documents: A—Form of agreement and general conditions of the contract. B—Bond of Suretyship. C—Form of subcontract. D—Letter of Acceptance of subcontractor's proposal. The documents are published and for sale by the institute at its headquarters, The Octagon, Washington, D. C.

I. NOTES PUBLISHED BY THE AMERICAN INSTITUTE OF ARCHITECTS ON THE STANDARD DOCUMENTS

THE CONSTRUCTION OF THE DOCUMENTS.

An Agreement, Drawings, and Specifications are the necessary parts of a building contract. Many conditions of a general character may be placed at will in the Agreement or in the Specifications. It is, however, wise to assemble them in a single document and, since they have as much bearing on the Drawings as on the Specifications, and even more on the business relations of the contracting parties, they are properly called the "General Conditions of the Contract." As the Agreement, General Conditions, Drawings, and Specifications are the constituent elements of the contract and are acknowledged as such in the Agreement, they are correctly termed the Contract Documents. Statements made in any one of them are just as binding as if made in the Agreement.

The Institute's forms, although intended for use in actual practice, should also be regarded as a code of reference representing the judgment of the Institute as to what constitutes good practice and as such they may be drawn upon by architects in improving their own forms. Although the forms are suited for use in connection with a single or general contract, they are equally applicable to an operation conducted under separate contracts.

NOTES ON THE AGREEMENT

PAYMENTS.—When the system of monthly payments is adopted, the following form may be used in filling the final blank in Article 3 of the Agreemnt:

"On or about the ..... day of each month, ... per cent of the value, proportionate to the amount of the Contract, of labor and materials incorporated in the work up to the first day of that month as estimated by the Architect, less the aggregate of previous payments. On the substantial completion of the entire work, a sum sufficient to increase the total payments to ..... per cent. of the contract price, and ..... days thereafter, provided the work be fully completed and the contract fully performed, the balance due under the Contract."

NOTES ON THE GENERAL CONDITIONS OF THE CONTRACT

In some cases the Articles as printed do not include all necessary General Conditions of the Contract. The Architect will then add such others as he deems wise.

Many architects include in their General Conditions one or more of the subjects named below. Most of these are better placed in the specifications for the various trades; and others, though suited for inclusion in the General Conditions, are not always needed. Among these subjects are:

Watchmen, Heating during construction, Protection and care of trees and shrubs, Protective coverings in general, Vault permits, Sidewalks, Fences, Ladders, Temporary stairways, Scaffolding, Sheds, Sanitary conveniences, Offices and their furniture, Telephone, Temporary wiring and electric lights, Lanterns, Temporary enclosure from weather, Keeping building and cellar free from water, Chases, Photographs, Checking by surveyor and his certificate, Contractor to work overtime if required, Insurance against lightning, wind storms, hail, and earthquake, Contractor to keep the work in repair, Owner to furnish survey, Contractors

to lay out the work, giving lines and levels, Bracing building during construction, Stoppage of work in freezing weather, Charges for extra copies of drawings, etc.

ARTICLE 2, *Correlation of Documents.*—This article describes the Contract Documents as complementary. Architects who wish to ascribe to them an order of precedence should add such a note to the General Conditions.

ARTICLE 10, *The Architect's Decisions.*—Articles 10 and 45 provide for general arbitration of all questions, but Article 10 permits the exception of decisions of the Architect from this rule in three ways: (a) By provisions already in the General Conditions, Articles 18 and 24; (b) By additions to the General Conditions; (c) By special exceptions in the Specifications. The object of this provision is to enable each Archtiect to make such exceptions as he sees fit to the general rule of arbitration so provided. It is suggested that the best method of doing this, if any change is desired, is by an addition to the General Conditions in the form of a special article.

ARTICLE 21, *Fire Insurance.*—There is not at present any standard method of carrying insurance on buildings in course of construction. Great confusion, delay and difficulty of settlement generally arise when the Owner and several contractors and subcontractors insure independently or "as their interests may appear." Insurance men agree that the method covered in the first paragraph of Article 21 is excellent and that experience shows that under it settlement after a fire can be more quickly and readily effected than by any other method.

The Owner's duty under this Article is very simple if he will pay the entire premium in advance under an arrangement with the Insurer which provides a reasonable rebate on account of the gradual growth of value. It is expected that Underwriters will shortly issue a standard form of such a policy.

ARTICLE 29, *Liens.*—Owing to the diversity of the lien laws in the several States, it is impracticable to draft an article suited for use in all, but it is thought that Article 29 is of general applicability. In certain States, where the laws permit a waiver of lien, special provision must be made in the documents if the Owner is to secure such protection.

ARTICLE 43, *Subcontracts.*—Architects who wish to assist in stamping out the abuse of playing off one Subcontractor against another should insist upon receiving, with each proposal, a list of intended Subcontractors, as explained in the second paragraph of Article 43, and as illustrated in the last note on this cover.

ARTICLE 44, *Relations of Contractor and Subcontractor.*—This article is intended to promote standard and equitable relations between a contractor and his subcontractors, and to insure a uniformity of conditions similar to those binding the Owner to the Contractor.

ARTICLE 45, *Form of Arbitration.*—As the laws relative to arbitration differ greatly in the several States, the Architect should carefully verify Article 45 as to its legality and effectiveness in the State in which the work is to be done.

NOTES ON THE BOND OF SURETYSHIP

The bond of Suretyship is drawn for use with either corporate or individual sureties. If a bond is to be given, this form, without additions or omissions, should be insisted upon to insure a full measure of protection. Proper certification that those signing the bond have authority so to sign should accompany the bond.

AUTHORITY TO EXECUTE A CONTRACT OR BOND.

When the Contractor, the Owner, or the Surety is a corporation, it is important that any Agreement or Bond executed by such corporation should be accompanied by a certificate, such as the following, showing that power so to sign is duly vested in those signing:

"At a meeting of the Board of Directors of the .....
..... duly notified and held in .....
on ....., 19....., a quorum being present, it was

VOTED: *That ..... the .....*
be and he is hereby authorized and directed in the name and behalf of this Corporation, and under its corporate seal, to execute and deliver a contract with .....
for a ..... at .....
for the sum of $.....; said contract to be in such form and subject to such conditions as said .....
shall see fit. And said ..... is hereby further authorized and directed in the name and behalf of this Corporation and under its corporate seal, to execute and deliver to said Owner any bond or bonds he may see fit for the performance of said contract by this Corporation.

A True Copy.

Attest: ....., Secretary.

The same form, with omission of last sentence, applies to the Owner.

THE DEVELOPMENT OF THE STANDARD DOCUMENTS

In the year 1887 the American Institute of Architects, the Western Association of Architects and the National Association of Builders, thinking it desirable to establish better practice in the matter of building contracts, undertook the preparation of a form of contract satisfactory to all. Under the name of "The Uniform Contract" this form attained wide acceptance and has been long in use.

About the year 1907, feeling that practice had advanced to a point no longer fully reflected by the Uniform Contract, the Institute undertook a general study of the subject with a view to developing a form of contract clear in thought, equitable, applicable to work of almost all classes, binding in law and a standard of good practice.

The work was entrusted to the Standing Committee on Contracts and Specifications, who spent four years on it, studying the Uniform Contract and forms in use by some thirty well-known architects, submitted various drafts for criticism to the Chapters of the Institute and to engineers, contractors and architects throughout the country.

The documents were prepared under the advice of Francis Fisher Kane, Esq., Counsel for the Institute, and Ernest Eidlitz, Esq., and with the able and careful criticism of Prof. Samuel Williston of the Harvard Law School, and with the assistance of James W. Pryor, Esq., in their editing. The Institute gave its approval to the work in 1911.

The Standing Committee on Contracts and Specifications, during the preparation of the first edition of the Standard Forms, consisted of Grosvenor Atterbury, Chairman; Allen B. Pond, Secretary; Frank Miles Day, William A. Boring, Frank C. Baldwin, Frank W. Ferguson, Alfred Stone and G. L. Heins.

Criticisms of the first edition of the Documents were invited by the Institute and during the year 1913 a group of architects and builders in Boston, known as the Joint Committee of the Boston Society of Architects, and of the Master Builders' Assoication, gave much sincere study

to the subject. At the same time the National Association of Builders' Exchanges offered a detailed criticism of the documents.

In 1914 the Institute instructed its Standing Committee on Contracts and Specifications to undertake a general revision with a view to making the Conditions simpler in wording and more equitable. The Committee was empowered to hold conferences with organizations so desiring. Subcommittees for the territory of the several Chapters of the Institute were appointed and collaborated with the Standing Committee.

The Boston group presented its ideas in the form of an entirely new draft which proved of high value and its Chairman, Mr. W. Stanley Parker, was present with the Standing Committee at nearly all its meetings. The Committee had a joint meeting with representatives of the National Association of Builders' Exchanges and thereafter the Counsel of the Association, Wm. B. King, Esq., and the Counsel of the Institute, Louis Barcroft Runk, Esq., collaborated most effectively with the Committee.

The General Conditions were entirely rewritten and in response to the strong desire of contractors and subcontractors, the principle of general arbitration, subject to limitations in the documents, was adopted, and provisions relative to the relations of the Contractor and his subcontractors were included in the documents.

After much study, conference and criticism, a draft of the second edition was issued by authority of the Institute, April 1, 1915.

During the revision of the documents, the Standing Committee on Contracts and Specifications consisted of Frank Miles Day, Chairman; Allen B. Pond, Sullivan W. Jones, Clarence A. Martin, Norman M. Isham, Octavius Morgan, Thomas Nolan, A. O. Elzner, M. B. Medary, Jr., Jos. Evans Sperry, Frank W. Ferguson and Sam. Stone.

NOTES ON THE INVITATION TO BID, INSTRUCTIONS TO BIDDERS, AND FORM OF PROPOSAL

The Institute formerly issued the above named forms which contain much of value. Experience, however, showed that they had generally to be adapted to specific cases. They are, therefore, reproduced here so that Architcts may draw from them whatever they deem useful.

FORM OF INVITATION TO SUBMIT A PROPOSAL

Dear Sir: You are invited to submit a proposal for .....
Drawings, Specifications and other information may be procured from this office on and after ..... All documents must be returned to this office not later than .....

To be entitled to consideration the proposal must be made upon the form provided by the Architect, which must be fully completed in accordance with the accompanying "Instructions to Bidders" and must be delivered to this office not later than .....

Very truly yours,

.....

FORM OF INSTRUCTIONS TO BIDDERS

Proposals, to be entitled to consideration, must be made in accordance with the following instructions:

Proposals shall be made upon the form provided therefor, and all blank spaces in the form shall be fully filled; numbers shall be stated both in writing and in figures; the signature shall be in long hand; and the completed form shall be without interlineation, alteration or erasure.

Proposals shall not contain any recapitulation of the work to be done. No oral, telegraphic or telephonic proposals or modifications will be considered.

Proposals shall be addressed to the Owner, in care of the Architect, and shall be delivered to the Architect enclosed in an opaque sealed envelope addressed to him, marked "Proposal" and bearing the title of the work and the name of the Bidder.

Should a bidder find discrepancies in, or omissions from, the drawings or documents, or should he be in doubt as to their meaning, he should at once notify the Architect, who will send a written instruction to all bidders. Neither Owner nor Architect will be responsible for any oral instructions.

Before submitting a proposal, bidders should carefully examine the drawings and specifications, visit the site or work, fully inform themselves as to all existing conditions and limitations and shall include in the Proposal a sum to cover the cost of all items included in the Contract.

The competency and responsibility of bidders and of their proposed subcontractors will be considered in making the award. The Owner does not obligate himself to accept the lowest or any other bid.

Provision will be made in the Agreement for payments on account in the following words: (Insert the provision).

Any Bulletins issued during the time of bidding are to be covered in the proposal and in closing a contract they will become a part thereof.

FORM OF PROPOSAL

(The Proposal should be dated and addressed to the Owner in care of the Architect.)

DEAR SIR: Having carefully examined the Instructions to Bidders, the General Conditions of the Contract and Specifications entitled .....

(Here insert the caption descriptive of the work as used therein.)

and the Drawings, similarly entitled, numbered ....., as well as the premises and the conditions affecting the work, the Undersigned proposes to furnish all materials and labor called for by them for .....

(Here insert, in case all the work therein described is to be covered by one contract, "the entire work." In case of a partial contract insert name of the trade or trades to be covered and the numbers of the pages of the Specifications on which the work is described.)

in accordance with the said documents for the sum of ..... Dollars ($.....) and to execute a contract for the above work, for the above stated compensation, in the form of the Standard Agreement of the American Institute of Architects (second edition), provided that he be notified of the acceptance of this proposal within ..... days of the time set for the submission of bids.

Very truly yours,

.....

Suggestions to Architects Using the Above Form of Proposal

The above form includes only such statements as will probably be required in any Proposal. Additions will usually have to be made to it. Suggestions suited to certain conditions are offered in the following notes:

If the Bidder is to name the time required for completing the work, insert such a clause as the following:

The Undersigned agrees, if awarded the Contract, to complete it within ..... days, Sundays and whole holidays not included.

If liquidated damages are to be required, insert the following:

And further agrees that, from the compensation otherwise to be paid, the Owner may retain the sum of ..... dollars ($.....) for each day thereafter, Sundays and whole holidays not included, that

the work remains uncompleted, which sum is agreed upon as the proper measure of liquidated damages which the Owner will sustain per diem by reason of the failure of the undersigned to complete the work at the time stipulated, and this sum is not to be construed as in any sense a penalty.

If a bond is required, insert the following:

The Undersigned agrees, if awarded the Contract, to execute and deliver to the Architect within ..... days after the signing of the Contract, a satisfactory bond in the form issued by the American Institute of Architects (second edition) and in the sum of ....., extending from the time of signature for ..... months from the day on which the final payment under the contract falls due, and further agrees that if such bond be not required, he will deduct from the proposal price the sum of ..... dollars ($.....).

If a certified check is required, the following clause should be inserted:

The Undersigned further agrees that the certified check payable to ....., Owner, accompanying this proposal, is left in escrow with the Architect; that its amount is the measure of liquidated damages which the Owner will sustain by the failure of the Undersigned to execute and deliver the above named Agreement and bond, and that if the Undersigned defaults in executing that Agreement within..... days of written notification of the award of the contract to him or in furnishing the Bond within ..... days thereafter, then the check shall become the property of the Owner, but if this proposal is not accepted within ..... days of the time set for the submission of bids, or if the Undersigned executes and delivers said Contract and Bond, the check shall be returned to him on receipt therefor.

If alternative proposals are required, they should be set forth, as for example:

Should ..... be substituted for ..... the Undersigned agrees to deduct (or will require the addition of) ..... dollars ($.....) from (or to) the proposed sum.

If unit prices are required as a part of the proposal, they should be set forth as, for example:

The Undersigned agrees that work added shall be computed at the following prices, and that work omitted shall be computed at ..... per cent less than these prices.
Concrete foundations ..... per cubic yard
Rough brickwork ..... per thousand
Plastering ..... per yard

If the names of subcontractors whom the Contractor proposes to employ are required as a part of the Proposal this requirement should be set forth, as, for example:

In case of obtaining the award the Undersigned will employ, subject to the Architect's approval, subcontractors in each of the several trades selected from the following list (one or more names must be inserted for each trade):
Excavation .....
Stone Masonry .....
Brickwork .....
etc., etc.

FORM 19642-S.

II. THE UNIFORM CONTRACT

Copyrighted, 1905, by the American Institute of Architects, Washington, D. C.
E. G. Soltmann, N. Y., Licensee for Exclusive Publication.

Revised 1907

THIS AGREEMENT, made the ..... day of ..... in the year one thousand nine hundred and ..... by and between .....

....., party of the first part (hereinafter designated the Contractor), and .....

party of the second part (hereinafter designated the Owner),

Witnesseth that the Contractor , in consideration of the agreements herein made by the Owner , agree with the said Owner as follows:

Article I. The Contractor shall and will provide all the materials and perform all the work for the .....

as shown on the drawings and described in the specifications prepared by .....

Architect, which drawings and specifications are identified by the signatures of the parties hereto, and become hereby a part of this contract.

Art. II. It is understood and agreed by and between the parties hereto that the work included in this contract is to be done under the direction of the said Architect, and that his decision as to the true construction and meaning of the drawings and specifications shall be final. It is also understood and agreed by and between the parties hereto that such additional drawings and explanations as may be necessary to detail and illustrate the work to be done are to be furnished by said Architect, and they agree to conform to and abide by the same so far as they may be consistent with the purpose and intent of the original drawings and specifications referred to in Art. I.

It is further understood and agreed by the parties hereto that any and all drawings and specifications prepared for the purposes of this contract by the said Architect are and remain his property, and that all charges for the use of the same, and for the services of said Architect, are to be paid by the said Owner .

Art. III. No alterations shall be made in the work except upon written order of the Architect ; the amount to be paid by the Owner or allowed by the Contractor by virtue of such altera-

tions to be stated in said order. Should the Owner and Contractor not agree as to amount to be paid or allowed, the work shall go on under the order required above, and in case of failure to agree, the determination of said amount shall be referred to arbitration, as provided for in Art. XII of this contract.

Art. IV. The Contractor shall provide sufficient, safe and proper facilities at all times for the inspection of the work by the Architect or his authorized representatives; shall, within twenty-four hours after receiving written notice from the Architect to that effect, proceed to remove from the grounds or buildings all materials condemned by him, whether worked or unworked, and to take down all portions of the work which the Architect shall by like written notice condemn as unsound or improper, or as in any way failing to conform to the drawings and specifications, and shall make good all work damaged or destroyed thereby.

Art. V. Should the Contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen, or of materials of the proper quality, or fail in any respect to prosecute the work with promptness and diligence, or fail in the performance of any of the agreements herein contained, such refusal, neglect or failure being certified by the Architect, the Owner shall be at liberty, after three days written notice to the Contractor , to provide any such labor or materials, and to deduct the cost thereof from any money then due or thereafter to become due to the Contractor under this contract; and if the Architect shall certify that such refusal, neglect or failure is sufficient ground for such action, the Owner shall also be at liberty to terminate the employment of the Contractor for the said work and to enter upon the premises and take possession, for the purpose of completing the work included under this contract, of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work, and to provide the materials therefor; and in case of such discontinuance of the employment of the Contractor ..... shall not be entitled to receive any further payment under this contract until the said work shall be wholly finished, at which time, if the unpaid balance of the amount to be paid under this contract shall exceed the expense incurred by the Owner in finishing the work, such excess shall be paid by the Owner to the Contractor ; but if such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner . The expense incurred by the Owner as herein provided, either for furnishing materials or for finishing the work, and any damage incurred through such default, shall be audited and certified by the Architect, whose certificate thereof shall be conclusive upon the parties.

Art. VI. The Contractor shall complete the several portions, and the whole of the work comprehended in this Agreement by and at the time or times hereinafter stated, to wit:

.....

.....

Art. VII. Should the Contractor be delayed in the prosecution or completion of the work by the act, neglect or default of the Owner , of the Architect , or of any other contractor employed by the Owner upon the work, or by any damage caused by fire or other casualty for which the Contractor ..... not responsible, or by combined action of workmen in no wise caused by or resulting from default or collusion on the part of the Contractor , then the time herein fixed for the completion of the work shall be extended for a period equivalent to the time lost by reason of any or all the causes aforesaid, which extended period shall be determined and fixed by the Architect ; but no such allowance shall be made unless a claim therefor is presented in writing to the Architect within forty-eight hours of the occurrence of such delay.

Art. VIII. The Owner agree to provide all labor and materials essential to the conduct of this work not included in this contract in such manner as not to delay its progress, and in the event of failure so to do, thereby causing loss to the Contractor , agree that ..... will reimburse the Contractor for such loss; and the Contractor agree that if ..... shall delay the progress of the work so as to cause loss for which the Owner shall become liable, then ..... shall reimburse the Owner for such loss. Should the Owner and Contractor fail to agree as to the amount of loss comprehended in this Article, the determination of the amount shall be referred to arbitration as provided in Art. XII of this contract.

Art. IX. It is hereby mutually agreed between the parties hereto that the sum to be paid by the Owner to the Contractor for said work and materials shall be .....

.....

subject to additions and deductions as hereinbefore provided, and that such sum shall be paid by the Owner to the Contractor , in current funds, and only upon certificates of the Architect, as follows:

.....

.....

The final payment shall be made within ..... days after the completion of the work included in this contract, and all payments shall be due when certificates for the same are issued.

If at any time there shall be evidence of any lien or claim for which, if established, the Owner of the said premises might become liable, and which is chargeable to the Contractor , the Owner shall have the right to retain out of any payment then due or thereafter to become due an amount sufficient to completely indemnify ..... against such lien or claim. Should there prove to be any such claim after all payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging any lien on said premises made obligatory in consequence of the Contractor default.

Art. X. It is further mutually agreed between the parties hereto that no certificate given or payment made under this contract, except the final certificate or final payment, shall be conclusive evidence of the performance of this contract, either wholly or in part, and that no payment shall be construed to be an acceptance of defective work or improper materials.

Art. XI. The Owner shall during the progress of the work maintain insurance on same against loss or damage by fire,

.....

the policies to cover all work incorporated in the building, and all materials for the same in or about the premises, and to be made payable to the parties hereto, as their interest may appear.

Art. XII. In case the Owner and Contractor fail to agree in relation to matters of payment, allowance or loss referred to in Arts. III or VIII of this contract, or should either of them dissent from the decision of the Architect referred to in Art. VII of this contract, which dissent shall have been filed in writing with the Architect within ten days of the announcement of such decision, then the matter shall be referred to a Board of Arbitration to consist of one person selected by the Owner , and one person selected by the Contractor , these two to select a third. The decision of any two of this Board shall be final and binding on both parties hereto. Each party hereto shall pay one-half of the expense of such reference.

.....

.....

The said parties for themselves, their heirs, successors, executors, administrators and assigns, do hereby agree to the full performance of the covenants herein contained.

In Witness Whereof, the parties to these presents have hereunto set their hands and seals, the day and year first above written.

In Presence of

NOTE.—This Form of Agreement is approved by the American Institute of Architects when used with the General Conditions of the Contract issued by the Institute. (See Form IV.)

III. THE STANDARD FORM OF AGREEMENT BETWEEN CONTRACTOR AND OWNER

ISSUED BY THE AMERICAN INSTITUTE OF ARCHITECTS

This form has been approved by the National Association of Builders' Exchanges, The National Association of Master Plumbers, and the National Association of Master Steam and Hot Water Fitters.

SECOND EDITION, COPYRIGHT 1915 BY THE AMERICAN INSTITUTE OF ARCHITECTS, THE OCTAGON, WASHINGTON, D. C. THIS FORM IS TO BE USED ONLY WITH THE STANDARD GENERAL CONDITIONS OF THE CONTRACT

THIS AGREEMENT made the ..... day of ..... in the year Nineteen Hundred and ..... by and between ..... hereinafter called the Contractor, and ...., hereinafter called the Owner,

Witnesseth, that the Contractor and the Owner for the consideration hereinafter named agree as follows:

Article I. The Contractor agrees to provide all the materials and to perform all the work shown on the Drawings and described in the Specifications entitled .....

(Here insert the caption descriptive of the work as used in the Proposal, General Conditions, Specifications, and upon the Drawings.)

.....

prepared by ..... acting as, and in these Contract Documents entitled the Architect, and to do everything required by the General Conditions of the Contract, the Specifications and the Drawings.

Article 2. The Contractor agrees that the work under this Contract shall be substantially completed .....

(Here insert the date or dates of completion, and stipulations as to liquidated damages, if any.)

.....

Article 3. The Owner agrees to pay the Contractor in current funds for the performance of the Contract ..... ($.....) subject to additions and deductions as provided in the General Conditions of the Contract and to make payments on account thereof as provided therein, as follows:

(Here insert provisions as to the method and times of payments.)

.....

Article 4. The Contractor and the Owner agree that the General Conditions of the Contract, the Specifications and the Drawings, together with this Agreement, form the Contract, and that they are as fully a part of the Contract as if hereto attached or

herein repeated; and that the following is an exact enumeration of the Specifications and Drawings:

.....

The Contractor and the Owner for themselves, their successors, executors, administrators and assigns, hereby agree to the full performance of the covenants herein contained.

In Witness Whereof they have hereunto set their hands and seals, the day and year first above written.

In Presence of

..... } as to ..... (Seal)
..... } as to ..... (Seal)

TITLE PAGE

TITLE AND LOCATION OF THE WORK:
NAME AND ADDRESS OF THE OWNER:
NAME AND ADDRESS OF THE ARCHITECT:
TITLES OF DOCUMENTS BOUND HEREWITH AND ENUMERATION OF DRAWINGS:

IV. THE GENERAL CONDITIONS OF THE CONTRACT

Standard Form of the American Institute of Architects

This form has been approved by the National Association of Builders' Exchanges, The National Association of Master Plumbers, and the National Association of Master Steam and Hot Water Fitters.

SECOND EDITION, COPYRIGHT 1915, BY THE AMERICAN INSTITUTE OF ARCHITECTS, THE OCTAGON, WASHINGTON, D. C.

Index to the Articles of the General Conditions

1. Definitions
2. Documents
3. Details and Instructions
4. Copies Furnished
5. Shop Drawings
6. Drawings on the Work
7. Ownership of Drawings
8. Samples
9. The Architect's Status
10. The Architect's Decisions
11. Foreman, Supervision
12. Materials, Labor, Appliances
13. Inspection of Work
14. Correction before Final Payment
15. Deductions for Uncorrected Work
16. Correction after Final Payment
17. Protection of Work and Property
18. Emergencies
19. Damage to Persons
20. Liability Insurance
21. Fire Insurance
22. Guaranty Bonds
23. Cash Allowances
24. Changes in the Work
25. Claims for Extras
26. Applications for Payments
27. Certificates and Payments
28. Payments Withheld
29. Liens
30. Permits and Regulations
31. Royalties and Patents
32. Use of Premises
33. Cleaning Up
34. Cutting, Patching and Digging
35. Delays
36. Owner's Right to Do Work
37. Owner's Right to Terminte Contract
38. Contractor's Right to Stop Work or Terminate Contract
39. Damages
40. Mutual Responsibility of Contractors
41. Separate Contracts
42. Assignment
43. Subcontracts
44. Relations of Contractor and Subcontractor
45. Arbitration

Article 1. Principles and Definitions.—

(a) The Contract Documents consist of the Agreement, the General Conditions of the Contract, the Drawings and Specifications. These form the Contract.

(b) The Owner, the Contractor and the Architect are those named as such in the Agreement. They are treated throughout the Contract Documents as if each were of the singular number and masculine gender.

(c) The Contractor shall, as in Article 43, be responsible to the Owner for the acts and omissions of his subcontractors and of all persons directly or indirectly employed by him or them in connection with the work.

(d) The term Subcontractor includes only those having a direct contract with the Contractor and it includes one who furnishes material even though he does not work.

(e) The term "person" or "anyone" as employed herein shall be taken to include a firm or corporation.

(f) Written notice shall be deemed to have been duly served if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or mailed to the last business address known to him who gives the notice.

(g) The term "work" of the Contractor or Subcontractor includes labor or materials or both.

(h) When the words "approved," "satisfactory," "equal to," "proper," "as directed," etc., are used, approval, etc., by the Architect is understood.

(j) All time limits stated in the Contract Documents are of the essence of the contract.

(k) The law of the place of building shall govern the construction of this contract.

Art. 2. Execution, Correlation and Intent of Documents.—The Contract Documents shall be signed in duplicate by the Owner and Contractor. In case of failure to sign the General Conditions, Drawings or Specifications the Architect shall identify them. Even though the signatures of the Owner and the Contractor may have been attested by witnesses they may be proved by any competent evidence.

The Contract Documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the documents is to include all labor and materials reasonably necessary for the proper execution of the work. It is not intended, however, that materials or work not covered by or properly inferable from any heading, branch, class or trade of the specifications shall be supplied unless distinctly so noted on the drawings. Materials or work described in words which

so applied have a well-known technical or trade meaning shall be held to refer to such recognized standards.

Art. 3. Detail Drawings and Instructions.—The Architect shall furnish, with reasonable promptness, additional instructions, by means of drawings or otherwise, necessary for the proper execution of the work. All such drawings and instructions shall be consistent with the Contract Documents, true developments thereof, and reasonably inferable therefrom. The work shall be executed in conformity therewith and the Contractor shall do no work without proper drawings and instructions.

The Contractor and the Architect, if either so requests, shall jointly prepare a schedule, subject to change from time to time in accordance with the progress of the work, fixing the latest dates at which the various detail drawings will be required, and the Architect shall furnish them in accordance with that schedule. Under like conditions, a schedule shall be prepared, fixing dates for the submission of shop drawings, for the beginning of manufacture and installation of materials and for the completion of the various parts of the work.

Art. 4. Copies Furnished.—Unless Otherwise provided in the Contract Documents the Architect will furnish to the Contractor, free of charge, all copies of drawings and specifications reasonably necessary for the execution of the work.

Art. 5. Shop Drawings.—The Contractor shall submit two copies of all shop or setting drawings and schedules required for the work of the various trades and the Architect shall pass upon them with reasonable promptness. The Contractor shall make any corrections required by the Architect, file with him two corrected copies and furnish such copies as may be needed. The Architect's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless he has in writing called the Architect's attention to such deviations at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings or schedules.

Art. 6. Drawings and Specifications on the Work.—The Contractor shall keep one copy of all drawings and specifications on the work, in good order, available to the Architect and to his representatives.

Art. 7. Ownership of Drawings and Models.—All drawings, specifications and copies thereof furnished by the Architect are his property. They are not to be used on other work and, with the exception of the signed contract set, are to be returned to him on request, at the completion of the work. All models are the property of the Owner.

Art. 8. Samples.—The Contractor shall furnish for approval all samples as directed. The work shall be in strict accordance with approved samples.

Art. 9. The Architect's Status.—The Architect shall have general supervision and direction of the work. He is not the agent of the Owner, except as provided in the Contract Documents, and when in special instances he is authorized by the Owner so to act, and in such instances he shall, upon request, show the Contractor written authority. He has authority to stop the work whenever such stoppage may be necessary to insure the proper execution of the Contract.

In case of the termination of the employment of the Architect, the Owner shall appoint a capable and reputable Architect, whose status under the contract shall be that of the former Architect.

Art. 10. The Architect's Decisions.—The Architect shall, within a reasonable time, make decisions on all claims of the Owner or Contractor and on all other matters relating to the execution and progress of the work or the interpretation of the Contract Documents.

Except as may be otherwise expressly provided in or appended to these General Conditions or as particularly set forth in the specifications, all the Architect's decisions are subject to arbitration.

Art. 11. Foreman, Supervision.—The Contractor shall keep on the work a competent general foreman and any necessary assistants, all satisfactory to the Architect. The general foreman shall not be changed except with the consent of the Architect. The foreman shall represent the Contractor in his absence and all directions given to him shall be as binding as if given to the Contractor. On written request such directions shall be confirmed in writing to the Contractor.

The Contractor shall give efficient supervision to the work, using his best skill and attention. He shall carefully study and compare all drawings, specifications and other instructions and shall at once report to the Architect any error, inconsistency or omission which he may discover.

Art. 12. Materials, Labor, Appliances.—Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light and power necessary for the execution of the work.

Unless otherwise specified, all materials shall be new and both workmanship and materials shall be of good quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

The Contractor shall not employ on the work any unfit person or anyone not skilled in the work assigned to him.

Art. 13. Inspection of Work.—The Owner, the Architect and their representatives shall at all times have access to the work wherever it is in preparation or progress and the Contractor shall provide proper facilities for such access and for inspection.

If the specifications, the Architect's instructions, laws, ordinances or any public authority require any work to be specially tested or approved, the Contractor shall give the Architect timely notice of its readiness for inspection and the Architect shall promptly inspect it. If any such work should be covered up without approval or consent, it must, if required by the Architect, be uncovered for examination at the Contractor's expense.

Re-examination of questioned work may be ordered by the Architect and, if found not in accordance with the Contract, all expense of re-examination and replacement shall be borne by the Contrator, otherwise it shall be allowed as extra work.

Art. 14. Correction of Work before Final Payment.—The Contractor shall promptly remove from the premises all materials, whether worked or unworked, and take down and remove all portions of the work condemned by the Architect as failing to conform to the Contract; and the Contractor shall promptly replace and re-execute his own work in accordance with the Contract and without expense to the Owner and shall bear the expense of making good all work of other contractors destroyed or damaged by such removal or replacement.

If the Contractor does not remove such condemned work and materials within a reasonable time, fixed by written notice, the Owner may remove them and may store the material at the expense of the Contractor. If the Contractor does not pay the expense of such removal within five days thereafter, the Owner may, upon ten days' written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor.

Art. 15. Deductions for Uncorrected Work.—If the Architect deems it inexpedient to correct work injured or not done in accordance with the Contract, the difference in value together with a fair allowance for damage shall be deducted, if acceptable to the Owner.

Art. 16. Correction of Work after Final Payment.—Neither the final certificate nor payment nor any provision in the Contract Documents shall relieve the Contractor of responsibility for negligence or faulty materials or workmanship within the extent and period provided by law and upon written notice he shall remedy any defects due thereto and pay for any damage to other work resulting therefrom. All questions arising under this Article shall be decided under Articles 10 and 45.

Art. 17. Protection of Work and Property.—The Contractor shall continuously maintain adequate protection of all his work from damage and shall protect the Owner's and adjacent property from injury arising in connection with this Contract. He shall make good any such damage or injury, except such as may be directly due to errors in the contract documents.

Art. 18. Emergencies.—In an emergency affecting the safety of life or of the structure or of adjoining property, not considered by the Contractor as within the provisions of Article 17, then the Contractor, without special instruction or authorization from the Architect or Owner, is hereby permitted to act, at his discretion, to prevent such threatened loss or injury, and he shall so act, without appeal, if so instructed or authorized. Any compensation claimed to be due to him therefor shall be determined under Articles 10 and 45 regardless of the limitations in Article 25 and the second paragraph of Article 24.

Art. 19. Damage to Persons.—In addition to the liability imposed by law upon the Contractor on account of bodily injury or death suffered through the Contractor's negligence, which liability is not impaired or otherwise affected hereby, the Contractor hereby assumes, in cases not embraced within such legal liability, the obligation to save the owner harmless and indemnify him from every expense, liability or payment (voluntary payments excepted), by reason of any injury to any person or persons, including death, suffered through any act or omission of the Contractor or any Subcontractor, or any one directly or indirectly employed by either of them, in the prosecution of any work included in this contract.

Art. 20. Liability Insurance.—The Contractor shall maintain such insurance as will protect him from claims under workmen's compensation acts and from any other claims for damages for personal injury, including death, which may arise from operations under this contract. Certificates of such insurance shall be filed with the Owner, if he so require, and shall be subject to his approval for adequacy of protection. The Owner shall be responsible for his own contingent liability.

Art. 21. Fire Insurance.—The Owner shall effect and maintain fire insurance upon the entire structure on which the work of this contract is to be done and upon all materials, tools and appliances in or adjacent thereto and intended for use thereon, to at least eighty per cent of the insurable value thereof. The loss, if any, is to be made adjustable with and payable to the Owner as Trustee for whom it may concern.

All policies shall be open to inspection by the Contractor. If the Owner fails to show them on request or if he fails to effect or maintain insurance as above, the Contractor may insure his

own interest and charge the cost thereof to the Owner. If the Contractor is damaged by failure of the Owner to maintain such insurance, he may rocover under Art. 39.

If required in writing by any party in interest, the Owner as Trustee shall, upon the occurrence of loss, give bond for the proper performance of his duties. He shall deposit any money received from insurance in an account separate from all his other funds and he shall distribute it in accordance with such agreement as the parties in interest may reach, or under an award of arbitrators appointed, one by the Owner, another by joint action of the other parties in interest, all other procedure being in accordance with Art. 45. If after loss no special agreement is made, replacement of injured work shall be ordered under Art. 24.

The Trustee shall have power to adjust and settle any loss with the insurers unless one of the contractors interested shall object in writing within three working days of the occurrence of loss and thereupon arbitrators shall be chosen as above. The Trustee shall in that case make settlement with the insurers in accordance with the directions of such arbitrators, who shall also, if distribution by arbitration is required, direct such distribution.

Art. 22. Guaranty Bonds.—The Owner shall have the right to require the Contractor to give bond covering the faithful performance of the contract and the payment of all obligations arising thereunder, in such form as the Owner may prescribe and with such sureties as he may approve. If such bond is required by instructions given previous to the receipt of bids, the premium shall be paid by the Contractor; if subsequent thereto, it shall be paid by the Owner.

Art. 23. Cash Allowances.—The Contractor shall include in the contract price all allowances named in the Contract Documents and shall cause the work so covered to be done by such contractors and for such sums as the Architect may direct, the contract sum being adjusted in conformity therewith. The Contractor, in making up his bid, shall add such sums for expenses and profit on account of cash allowances as he deems proper and no demand for expenses or profit other than those included in the contract sum shall be allowed. The Contractor shall not be required to employ for any such work a Subcontractor against whom he has a reasonable objection.

Art. 24. Changes in the Work.—The Owner, without invalidating the contract, may make changes by altering, adding to or deducting from the work, the contract sum being adjusted accordingly. All such work shall be executed under the conditions of the original contract except that any claim for extension of time caused thereby shall be adjusted at the time of ordering such change.

Except as provided in Articles 9 and 18, no change shall be made unless in pursuance of a written order from the Owner signed or countersigned by the Architect, and no claim for an addition to the contract sum shall be valid unless so ordered.

The value of any such change shall be determined in one or more of the following ways:

(a) By Estimate and Acceptance in a lump sum.

(b) By Unit Prices named in the contract or subsequently agreed upon.

(c) By Cost and Percentage or by Cost and a fixed fee.

(d) If none of the above methods is agreed upon, the Contractor, provided he receive an order in writing signed by the Owner and countersigned by the Architect, shall proceed with the work, no appeal to arbitration being allowed from such order to proceed.

In cases (c) and (d), the Contractor shall keep and present in such form as the Architect may direct, a correct account of the net cost of labor and materials, together with vouchers. In any case, the Architect shall certify to the amount, including a reasonable profit, due to the Contractor. Pending final determination of value, payments on account of changes shall be made on the Architect's certificate.

Art. 25. Claims for Extras.—If the Contractor claims that any instructions, by drawings or otherwise, involve extra cost under this contract, he shall give the Architect written notice thereof before proceeding to execute the work, and, in any event, within two weeks of receiving such instructions, and the procedure shall then be as provided in the last paragraph of Art. 24. No such claim shall be valid unless so made.

Art. 26. Applications for Payments.—The Contractor shall submit to the Architect an application for each payment, and, if required, receipts or other vouchers from Subcontractors showing his payments to them for materials and labor as required by Article 44.

If payments are made on valuation of work done, such application shall be submitted at least ten days before each payment falls due. If required, the Contractor shall before the first application submit to the Architect a schedule of values of the various parts of the work, aggregating the total sum of the contract, divided so as to facilitate payments to subcontractors in accordance with Article 44 (e) made out in such form as the Architect may direct and, if required, supported by evidence as to its correctness. This schedule, when approved by the Architect, shall be used as a basis for certificates of payment, unless it be found to be in error. In applying for payments, the Contractor shall submit a statement based upon this schedule and, if required,

itemized in such form as the Architect may direct, showing his right to the payment claimed.

Art. 27. Certificates and Payments.—If the Contractor has made application as above, the Architect shall, not later than the date when each payment falls due, issue to the Contractor a certificate for such amount as he decides to be properly due.

No certificate issued nor payment made to the Contractor, nor partial or entire use or occupancy of the work by the Owner shall be an acceptance of any work or materials not in accordance with this contract. The making and acceptance of the final payment shall constitute a waiver of all claims by the Owner, otherwise than under Articles 16 and 29 of these conditions or under requirement of the specifications, and of all claims by the Contractor, except those previously made and still unsettled.

Should the Owner fail to pay the sum named in any certificate of the Architect or in any award by arbitration, upon demand when due, the Contractor shall receive, in addition to the sum named in the certificate, interest thereon at the legal rate in force at the place of building.

Art. 28. Payments Withheld.—The Architect may withhold or, on account of subsequently discovered evidence, nullify the whole or a part of any certificate for payment to protect the Owner from loss on account of:

(a) Defective work not remedied.

(b) Claims filed or reasonable evidence indicating probable filing of claims.

(c) Failure of the Contractor to make payments properly to subcontractors or for material or labor.

(d) A reasonable doubt that the contract can be completed for the balance then unpaid.

When all the above grounds are removed certificates shall at once be issued for amounts withheld because of them.

Art. 29. Liens.—Neither the final payment nor any part of the retained percentage shall become due until the Contractor, if required, shall deliver to the Owner a complete release of all liens arising out of this contract, or receipts in full in lieu thereof and, if required in either case, an affidavit that the releases and receipts include all the labor and material for which a lien might be filed; but the Contractor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the Owner, to indemnify him against any claim by lien or otherwise. If any lien or claim remain unsatisfied after all payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging such lien or claim, including all costs and a reasonable attorney's fee.

Art. 30. Permits and Regulations.—The Contractor shall obtain and pay for all permits and licenses, but not permanent easements, and shall give all notices, pay all fees, and comply with all laws, ordinances, rules and regulations bearing on the work. If the drawings and specifications are at variance therewith, the Contractor shall notify the Architect in writing before the work is performed and the value of any necessary changes shall be adjusted under Art. 24. If any of the Contractor's work shall be done contrary to such laws, ordinances, rules and regulations, without such notice, he shall bear all costs arising therefrom.

Art. 31. Royalties and Patents.—The Contractor shall pay all royalties and license fees and shall defend all suits or claims whatsoever for infringement of any patent rights and shall save the Owner harmless from loss on account thereof.

Art. 32. Use of Premises.—The Contractor shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the Architect and shall not encumber the premises with his materials.

The Contractor shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.

The Contractor shall enforce the Architect's instructions regarding signs, advertisements, fires and smoking.

Art. 33. Cleaning Up.—The Contractor shall at all times keep the premises free from accumulations of waste material or rubbish caused by his employes or work and at the completion of the work he shall remove all his rubbish from and about the building and all his tools, scaffolding and surplus materials and shall leave his work clean and ready for use. In case of dispute the Owner may remove the rubbish and charge the cost to the several contractors as the Architect shall determine to be just.

Art. 34. Cutting, Patching and Digging.—The Contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts come together properly and fit it to receive or be received by work of other contractors shown upon, or reasonably implied by, the Drawings and Specifications for the completed structure and he shall make good after them, as the Architect may direct.

Any cost caused by defective or ill-timed work shall be borne by the party responsible therefor.

The Contractor shall not endanger any work by cutting, digging or otherwise and shall not cut or alter the work of any other contractor, save with the consent of the Architect.

Art. 35. Delays.—If the Contractor is delayed in the completion of the work by any act or neglect of the Owner or the Architect, or of any employe of either, or by any other con-

tractor employed by the Owner, or by changes ordered in the work, or by strikes, lockouts, fire, unavoidable casualties or any causes beyond the Contractor's control, or by delay authorized by the Architect pending arbitration, or by any cause which the Architect shall decide to justify the delay, then the time of completion shall be extended for such reasonable time as the Architect may decide.

No such extension shall be made for delay occurring more than seven days before claim therefor is made in writing to the Architect. In the case of a continuing cause of delay, only one claim is necessary.

If no schedule is made under Art. 3, no claim for delay shall be allowed on account of failure to furnish drawings until two weeks after demand for such drawings, and not then unless such claim be reasonable.

Art. 36. Owner's Right to Do Work.—If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this contract, the Owner, after three days' written notice to the Contractor, may, without prejudice to any other remedy he may have, make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the Contractor; provided, however, that the Architect shall approve both such action and the amount charged to the Contractor.

Art. 37. Owner's right to Terminate Contract.—If the Contractor should be adjudged a bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he should, except in cases recited in Article 35, persistently or repeatedly refuse or fail to supply enough properly skilled workmen or proper materials, or if he should fail to make prompt payment to subcontractors or for material or labor, or persistently disregard laws, ordinances or the instructions of the Architect, or otherwise be guilty of a substantial violation of any provision of the contract, then the Owner, upon the certificate of the Architect that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor seven days' written notice, terminate the employment of the Contractor and take possession of the premises and of all materials, tools and appliances thereon and finish the work by whatever method he may deem expedient. In such case the Contractor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the contract price shall exceed the expense of finishing the work, including compensation to the Architect for his additional services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner. The expense incurred by the Owner as herein provided,

and the damage incurred through the Contractor's default, shall be certified by the Architect.

Art. 38. Contractor's Right to Stop Work or Terminate Contract.—If the work should be stopped under an order of any court, for a period of three months, through no act or fault of the Contractor or of any one employed by him, or if the Owner should fail to pay to the Contractor, within seven days of its maturity and presentation, any sum certified by the Architect or awarded by arbitrators, then the Contractor may, upon three days' written notice to the Owner and the Architect, stop work or terminate this contract and recover from the Owner payment for all work executed and any loss sustained upon any plant or material and reasonable profit and damages.

Art. 39. Damages.—If either party to this contract should suffer damage by delay or otherwise, except as provided in Art. 40, because of any act or neglect of the other party or of any one employed by him, then he shall be reimbursed by the other party for such damage.

Claims under this clause shall be made in writing to the party liable within a reasonable time of the first observance of such damage and not later than the time of final payment, except in case of claims under Article 16, and shall be adjusted by agreement or arbitration.

Art. 40. Mutual Responsibility of Contractors.—Should the Contractor (see Art. 1 (**c**)) cause damage to any other person (see Art. 1 (**e**)) employed on the work, the Contractor agrees, upon due notice, to settle with such person by agreement or arbitration, if such person will so settle. If such person sues the Owner on account of any damage alleged to have been so sustained, the Owner shall notify the Contractor, who shall, at his own expense, defend such proceedings and, if any judgment against the Owner arise therefrom, the Contractor shall pay or satisfy it and pay all costs incurred by the Owner.

The Contractor, if damaged by any person held to the Owner by stipulations such as the above, agrees to settle with such person by agreement or arbitration and in no case to sue the Owner on account of such damage.

Art. 41. Separate Contracts.—The Owner reserves the right to let other contracts in connection with this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work and shall properly connect and co-ordinate his work with theirs.

If any part of the Contractor's work depends for proper execution or results upon the work of any other contractor, the Contractor shall inspect and promptly report to the Architect any defects in such work that render it unsuitable for such

proper execution and results. His failure so to inspect and report shall constitute an acceptance of the other contractor's work as fit and proper for the reception of his work, except as to defects which may develop in the other contractor's work after the execution of his work.

To insure the proper execution of his subsequent work the Contractor shall measure work already in place and shall at once report to the Architect any discrepancy between the executed work and the drawings.

Art. 42. Assignment.—Neither party to the Contract shall assign the contract without the written consent of the other, nor shall the Contractor assign any moneys due or to become due to him hereunder, without the previous written consent of the Owner.

Art. 43. Subcontracts.—The Contractor shall notify the Architect in writing of the names of subcontractors proposed for the principal parts of the work and for such others as the Architect may direct and shall not employ any that the Architect may within a reasonable time object to as incompetent or unfit.

The Contractor may in his discretion or shall, if so required, submit with his proposal, a list of subcontractors. If the change of any name on such list is required or permitted after signature of agreement, the contract price shall be increased or diminished by the difference between the two bids.

The Architect shall, on request, furnish to any subcontractor, wherever practicable, evidence of the amounts certified to on his account.

The Contractor agrees to be fully responsible to the Owner for the acts or omissions of his subcontractors and of anyone employed either directly or indirectly by him or them and this contractual obligation shall be in addition to the liability imposed by law upon the Contractor for bodily injuries or death through negligence in the cases covered by Article 19 hereof.

Nothing contained in the Contract Documents shall create any contractual relation between any subcontractor and the Owner.

Art. 44. Relations of Contractor and Subcontractor.—The Contractor agrees to bind every subcontractor and every subcontractor agrees to be bound, by the terms of the General Conditions, Drawings and Specifications, as far as applicable to his work, including the following provisions of this Article, unless specifically noted to the contrary in a subcontract approved in writing as adequate by the Owner or Architect.

The Subcontractor agrees—

(a) To be bound to the Contractor by the terms of the General Conditions, Drawings and Specifications and to assume toward him all the obligations and responsibilities that he, by those documents, assumes toward the Owner.

(b) To submit to the Contractor applications for payment in such reasonable time as to enable the Contractor to apply for payment under Article 26 of the General Conditions.

(c) To make all claims for extras, for extensions of time and for damages for delays or otherwise, to the Contractor in the manner provided in the General Conditions for like claims by the Contractor upon the Owner, except that the time for making claims for extra cost as under Article 25 of the General Conditions is one week.

The Contractor agrees—

(d) To be bound to the Subcontractor by all the obligations that the Owner assumes to the Contractor under the General Conditions, Drawings and Specifications and by all the provisions thereof affording remedies and redress to the Contractor from the Owner.

(e) To pay the Subcontractor, upon the issuance of certificates, if issued under the schedule of values described in Article 26 of the General Conditions, the amount allowed to the Contractor on account of the Subcontractor's work to the extent of the Subcontractor's interest therein.

(f) To pay the Subcontractor, upon the issuance of certificates, if issued otherwise than as in (e), so that at all times his total payments shall be as large in proportion to the value of the work done by him as the total amount certified to the Contractor is to the value of the work done by him.

(g) To pay the Subcontractor to such extent as may be provided by the Contract Documents or the subcontract, if either of these provides for earlier or larger payments than the above.

(h) To pay the Subcontractor on demand for his work or materials as far as executed and fixed in place, less the retained percentage, at the time the certificate should issue, even though the Architect fails to issue it for any cause not the fault of the Subcontractor.

(j) To pay the Subcontractor a just share of any fire insurance money received by him, the Contractor, under Article 21 of the General Conditions.

(k) To make no demand for liquidated damages or penalty for delay in any sum in excess of such amount as may be specifically named in the subcontract.

(l) That no claim for services rendered or materials furnished by the Contractor to the Subcontractor shall be valid unless written notice thereof is given by the Contractor to the Subcontractor during the first ten days of the calendar month following that in which the claim originated.

(m) To give the Subcontractor an opportunity to be present and to submit evidence in any arbitration involving his rights.

(n) To name as arbitrator under Article 45 of the General Conditions the person nominated by the Subcontractor, if the sole cause of dispute is the work, materials, rights or responsibilities of the Subcontractor; or, if of the Subcontractor and any other subcontractor jointly, to name as such arbitrator the person upon whom they agree.

The Contractor and the Subcontractor agree that—

(o) In the matter of arbitration, their rights and obligations and all procedure shall be analogous to those set forth in Article 45 of the General Conditions.

Nothing in this Article shall create any obligation on the part of the Owner to pay to or to see to the payment of any sums to any Subcontractor.

Art. 45. Arbitration.—Subject to the provisions of Article 10, all questions in dispute under this contract shall be submitted to arbitration at the choice of either party to the dispute.

The general procedure shall conform to the laws of the State in which the work lies and wherever permitted by law the decision of the arbitrators may be filed in court to carry it into effect.

The demand for arbitration shall be filed in writing with the Architect, in the case of an appeal from his decision, within ten days of its receipt and in any other case within a reasonable time after cause thereof and in no case later than the time of final payment, except as to questions arising under Article 16. If the Architect fails to make a decision within a reasonable time, an appeal to arbitration may be taken as if his decision had been rendered against the party appealing.

The parties may agree upon one arbitrator; otherwise there shall be three, one named in writing by each party, and the third chosen by these two arbitrators or, if they fail to select a third within ten days he shall be chosen by the presiding officer of the nearest Bar Association. Should the party demanding arbitration fail to name an arbitrator within ten days of his demand, his right to arbitration shall lapse. Should the other party fail to choose an arbitrator within such ten days, the Architect shall appoint such arbitrator. Should either party refuse or neglect to supply the arbitrators with any papers or information demanded in writing, the arbitrators are empowered by both parties to take ex parte proceedings.

The arbitrators shall act with promptness. The decision of any two shall be binding on all parties to the dispute. The decision of the arbitrators upon any question subject to arbitration under this contract shall be a condition precedent to any right of legal action.

The arbitrators, if they deem that the case demands it, are authorized to award to the party whose contention is sustained such sums as they shall deem proper for the time, expense and trouble incident to the appeal and, if the appeal was taken without reasonable cause, damages for delay. The arbitrators shall fix their own compensation, unless otherwise provided by agreement and shall assess the costs and charges of the arbitration upon either or both parties.

The award of the arbitrators must be in writing and, if in writing, shall not be open to objection on account of the form of the proceedings or the award.

A. I. A. Document 99

V. PROFESSIONAL PRACTICE OF ARCHITECTS, AND SCHEDULE OF USUAL AND PROPER MINIMUM CHARGES

Adopted by The American Institute of Architects and Revised, 1908

1. The Architect's professional services consist of the necessary conferences, the preparation of preliminary studies, working drawings, specifications, large scale and full size detail drawings, and of the general direction and supervision of the work, for which, except as hereinafter mentioned, the minimum charge, based upon the total cost* of the work complete, is six per cent.

2. On residential work, alterations to existing buildings, monuments, furniture, decorative and cabinet work and landscape architecture, it is proper to make a higher charge than above indicated.

3. The Architect is entitled to compensation for articles purchased under his direction, even though not designed by him.

4. If an operation is conducted under separate contracts, rather than under a general contract, it is proper to charge a special fee in addition to the charges mentioned elsewhere in this schedule.

5. Where the Architect is not otherwise retained, consultation fees for professional advice are to be paid in proportion to the importance of the question involved and services rendered.

6. Where heating, ventilating, mechanical, structural, electrical and sanitary problems are of such a nature as to require the services of a specialist, the Owner is to pay for such services.

*The total cost is to be interpreted as the cost of all materials and labor necessary to complete the work, plus contractors' profits and expenses, as such cost would be if all materials were new and all labor fully paid, at market prices current when the work was ordered.

Chemical and mechanical tests and surveys, when required, are to be paid for by the Owner.

7. Necessary traveling expenses are to be paid by the Owner.

8. If, after a definite scheme has been approved, changes in drawings, specifications or other documents are required by the Owner; or if the Architect be put to extra labor or expense by the delinquency or insolvency of a contractor, the Architect shall be paid for such additional services and expense.

9. Payments to the Architect are due as his work progresses in the following order: Upon completion of the preliminary studies, one-fifth of the entire fee; upon completion of specifications and general working drawings (exclusive of details), two-fifths additional, the remainder being due from time to time in proportion to the amount of service rendered. Until an actual estimate is received, charges are based upon the proposed cost of the work and payments received are on account of the entire fee.

10. In case of the abandonment or suspension of the work, the basis of settlement is to be as follows: For preliminary studies, a fee in accordance with the character and magnitude of the work; for preliminary studies, specifications and general working drawings (exclusive of details), three-fifths of the fee for complete services.

11. The supervision of an Architect (as distinguished from the continuous personal superintendence which may be secured by the employment of a clerk-of-the-works or superintendent of construction) means such inspection by the Architect or his deputy, of work in studios and shops or a building or other work in process of erection, completion or alteration, as he finds necessary to ascertain whether it is being executed in general conformity with his drawings and specifications or directions. He has authority to reject any part of the work which does not so conform and to order its removal and reconstruction. He has authority to act in emergencies that may arise in the course of construction, to order necessary changes, and to define the intent and meaning of the drawings and specifications. On operations where a clerk-of-the-work or superintendent of construction is required, the Architect shall employ such assistance at the Owner's expense.

12. Drawings and specifications, as instruments of service, are the property of the Architect.

RESIDENCE OF W. W. WILLITS, HIGHLAND PARK, ILLINOIS
Frank Lloyd Wright, Architect, Chicago, Illinois

AN ORDINANCE

ENTITLED

"THE BUILDING CODE OF THE CITY OF ———"

CHAPTER I

ADMINISTRATION AND SUPERVISION

SECTION 1. The name and title of this ordinance shall be "THE BUILDING CODE," and it shall be known and cited as such.

SEC. 2. The Building Code is hereby declared to be a remedial ordinance and shall be liberally construed, so as to secure the beneficial interests and purposes intended, and shall apply to all parts of the City of ————, hereafter referred to as the "City."

SEC. 3. The object and scope of this ordinance are the governing and regulating of the construction and erection, remodeling, alteration, repairing, moving and removal, and securing of buildings of any description in the City, and providing for the safety of all present and future buildings, and the safe use of them, and providing for all other matters pertaining to buildings and building operations in said City.

SEC. 4. It shall be unlawful and subject to the penalties hereinafter provided for any person, persons, firm, or corporation to construct, erect, repair, alter, add to, move or remove any building or portion thereof, or to carry on any building operations in the City, except in compliance with the terms and provisions of this Code.

SEC. 5. The Building Department shall consist of a Building Commissioner, Board of Advisors, and such Deputies, Engineers, Clerks, and plan and field Inspectors as may be required to properly carry on the work of the Department.

¶The Building Commissioner shall be appointed by the Mayor to serve during the latter's administration or during good behavior. He must be a citizen in good standing; an architect, engineer, or master builder of at least ten years' experience as such, and his name must be submitted by

the Mayor to the Council and approved by a majority vote before he can assume the office. His salary shall be fixed by the Council.

¶The Board of Advisors shall consist of the Building Commissioner and the chairman of the Council Building Committee *ex officio*, and one architect, one civil engineer, one sanitary engineer, one master builder, one lawyer, and one merchant. These latter six shall be appointed by the Mayor from among the names of three eligibles that shall be presented by each of the local chapters of the national or, in the absence of national, then the local societies of architects, of engineers, of sanitarians, of medicine, and by the Board of Trade, or the Chamber of Commerce or Commercial Club.

¶The Building Commissioner shall preside at all Board meetings or, in his absence, one of the members present shall be elected *pro tem*. The six lay members shall serve during the pleasure of the Mayor.

¶The Board shall assemble upon the call of the Building Commissioner.

¶The six lay members shall receive a *per diem* compensation fixed by the Council which shall also fix the limit of that compensation during any calendar year.

¶The Deputies and the Inspectors and the other employes of the Department shall be appointed by the Building Department from eligibles presented by the Civil Service and approved by the Mayor. These employes shall be continued in office under the rules of the Civil Service, and their duties and authority will be as prescribed and directed by the Commissioner of Buildings, hereafter called the "Commissioner."

¶The Commissioner's duties will be the administration of the Department and the enforcing of this Code.

¶If situations arise where the Code rulings are doubtful, or in the event of new construction not herein provided for being proposed, or in disputes between the Commissioner and citizens as to the interpretation of this Code, the Commissioner shall convene the Board and submit the matter to it. In all major matters not specifically provided for in this Code the Commissioner may only act with the approval of the Board. Five members present will constitute a quorum.

¶All appointments and discretionary functions, the preparation of amendments to this Code for presentation to Council, and all such matters will be attended to by the "Department," meaning the Commissioner and the Advisory Board, while the mere routine and administration will be done by the "Department," meaning, in such cases, the Commissioner and his duly authorized Deputies and Inspectors.

¶The Board of Advisors shall convene at least six times a year.

SEC. 6. The Building Department shall have the authority to stop the construction of any building, or the making of any alterations or repairs of any building, within said City, when the same is being done in a reckless or careless manner, or in violation of this Code or any ordinance of said City, and to order, in writing or parole, any and all persons in any way or manner whatever engaged in so constructing, altering, or repairing any such building, to stop and desist therefrom, and to have the authority in the case of any building or part thereof being in an unsafe condition, and so that said unsafe condition may be averted by the immediate application of precautionary measures, to cause such precautionary measures to be taken and all work necessary to render said building, or any part thereof, safe to be done, after having served written notice upon the owner, lessee, occupant, or agent of said building, personally.

¶The said Building Department shall have authority to direct the fire department, after written notice has been served upon the owner, lessee, occupant, or agent, personally, or without such notice if delay in serving such notice would in its opinion imperil the public safety, to tear down any defective or dangerous wall, stack, chimney, or any building or any part thereof, or in case of the destruction or partial destruction by fire, or by the action of the elements, any part of the building left standing, that is in its opinion unsafe, and it shall be the duty of the fire department to execute said order forthwith; and said Building Department shall immediately after such removal make report in detail to the Mayor and to the owner, giving in detail the conditions necessary for such action; and if the owner of such building is a non-resident of the City, a copy of such report shall be sent to his last known address, and a like copy served upon his agent or lessee of such premises.

¶The said Building Department is hereby empowered and whenever in its judgment occasion may require its inspectors or other officers, to enter into and upon any building, staging, other structure, or premises for the purpose of examining the same in relation to its proper ventilation, sanitation, and safety, and may make such orders in reference thereto as to them seem proper to the fulfillment of the provisions of this Code; and may make examinations of any buildings or premises to investigate divergence from or failure to comply with the provisions of this Code. And if the owner or lessee of such building, staging, or structure shall fail or neglect to comply with the requirements of such orders, the said Building Department may enter upon such premises, hire necessary help, and perform such work as is necessary in its judgment to be immediately performed so as to secure public and private safety. The expense so incurred shall be a lien on the property, and if the same remain unpaid sixty days

or more after legal notice, which shall be given by the City Auditor, that the same is due, an addition of three-quarters of one per centum shall be made to the amount of such assessment or expense for each month the same shall so remain unpaid after said lien is filed, and the same shall be collectable as a part of such assessment or expense, and be and remain a lien on such property in like manner and subject to the same modes of enforcement and collection as the principal sum to which the same is added; but said assessment shall be without prejudice to the right which the owner may have to recover from any lessee or other person liable for repairs.

SEC. 7. Before the erection, construction, or alteration of any building or part thereof, or shed, extension, or piazza is commenced, the owner, architect, or builder shall file with the Department a clear statement in writing of the proposed improvement, building, or alteration—together with a copy of the plans and specifications of the same, except where the cost as estimated by said Board does not exceed one hundred dollars—which statement shall show the size and map of the land upon which the structure referred to is to be erected or altered, and the distance of such proposed erection, alteration, or construction from the street line and from adjoining buildings on the same or adjacent lands or lots, a record of which shall be kept in the office of said Department.

¶Wherever plans are required for a building, addition, or detail, elevator, plumbing, etc., they shall be made by a reputable, responsible, and known architect, engineer, or specialist in the particular line of work planned. Plans by a carpenter for a house or drawings by a steam fitter for an elevator, for instances, will not fill this requirement.

¶Further, in making application for a permit the architect or engineer shall declare and sign a certificate that the work called for is in accordance with the spirit and letter of this code. Should it appear that any architect or engineer or specialist has made false statements in this form of application and that the work proposed is not in accord with this Code, then the Department may thereafter refuse to issue any further permits upon applications signed by him. This refusal, however, may only be made after he has been heard in his own defense before a meeting of the Advisory Board.

¶No part of any building shall extend beyond the building line and on street, except bay windows, cornices, and galleries above the first story or 10 feet clear above the grade line, and such projection beyond the building line shall not exceed 3 feet, provided, however, that in no case shall any building or part of a building extend beyond the street line, excepting

that anywhere above the second story the main roof cornice may project 24 inches and all minor cornices or belts 12 inches, and in buildings of 8 stories or more the main roof cornice may project 36 inches over the street line.

¶And the erection, construction, or alteration of such building or part thereof—shed, extension, or piazza—shall not be commenced or proceeded with until the said owner, architect, or builder shall receive a certificate or permit from said Department after an examination into such plans and specifications. And after it is satisfied that such sufficient means of fire protection, ventilation, sanitation, and general construction as therein described are provided as are conducive to safety and sanitation and are otherwise as provided in this Code, it shall issue said permit. Said plans and specifications shall remain on file at the office of the Building Department.

CHAPTER II

PLANS, FEES, PENALTIES, AND LICENSES

SEC. 8. All working plans and drawings other than diagrams, which are to be filed with the Building Department as provided in this Code, shall be drawn to a scale of not less than one-eighth of an inch to the foot on paper or cloth, in ink or by some process that will not fade or obliterate. All distances and dimensions must be accurately figured and drawings made explicit and complete, showing the sewerage and drain pipes, and location of all plumbing fixtures within such building. Each set of plans presented for permit must be accompanied by specifications describing all materials to be used in the proposed building, and both the plans and specifications must be approved by the Building Department before a permit is granted. Special drawings and details to illustrate any particular point or points shall be furnished when required.

SEC. 9. It shall be unlawful and subject to the penalties hereinafter provided to erase, alter, or modify any line, figures, or coloring contained upon drawing or specifications that in any way affect the structural, sanitary, or essential features of a building after they have been stamped by the

Building Department or filed with it for reference. If, during the progress of the execution of such work, it is desired to deviate in any manner affecting the construction or other essentials of the building from the terms of the application, drawings, plans, or specifications, as filed, notice of such intention to alter or deviate shall be given in writing to the Building Department and its written assent must be obtained before such alterations or deviations may be made. Alterations or deviations in buildings, which do not involve any change in their structural or sanitary parts or ways of ingress or egress, mere matters of decoration, may be made without permission from said Department.

SEC. 10. When the cost of any building alteration, elevator, plumbing, fire escape, or addition thereto, as herein specified, as estimated by the Building Department, does not exceed the sum of five hundred dollars, the fee for the permit, as provided in this Code, shall be one dollar; when the cost as so estimated is between five hundred dollars and two thousand dollars, two dollars; and when the cost as so estimated, is in excess of two thousand dollars, two dollars plus twenty-five cents for each one thousand dollars or fraction thereof in excess of two thousand dollars.

¶Further, in any case where it is decided to build a better class of building than called for in the limits wherein it is to be built and for the purpose it is intended, then the fee for the building permit shall be remitted wholly after the building is completed. But this can be done only upon the direction of the Advisory Board, the sole judge of the merits of the contention that the building is really better than is required by the Code for that district of the City. This is done for the purpose of encouraging better building in the City.

SEC. 11. And further, all new buildings shall be conspicuously labeled, at or near the entrance, just as to what class of construction they are—whether "fireproof," "slow-burning," or "ordinary"—and all old ones of a public or semi-public nature—halls, theaters, stores, hotels, apartments, etc.—shall be similarly labeled. In connection with these old structures there shall be an additional classification "dangerous." These labels shall be different in colors, so that each class is easily recognizable, and shall be affixed by the Building Department as quickly as it is possible to make the necessary inspection. All appeals will be heard and settled by the Advisory Board. It shall be a punishable offense to in any way hide or mar these signs or to advertise or call or distinguish the building by any superior classification than that which it has been labeled by the Department.

¶If, after a permit for the erection, alteration, or repair of any building

shall be granted, the operation called for by said permit shall not be commenced within six months from the date of said permit, a new permit shall be taken out by the owner or his agent and the fees herein fixed for the original permit shall again be paid therefor before any work on any such building is carried on or commenced; unless the commencement of such work has been delayed on account of strikes or such unavoidable occurrence, of which the Building Department shall be the sole judge.

SEC. 12. The said Building Department shall have authority to order stopped and suspended any and all work or building operations of any character whatsoever, which it deems being done or constructed in a careless, unsafe, or insanitary manner; and if the orders of said Department are not obeyed and the work so stopped or suspended, the contractor, foreman, person, or persons so disobeying such orders shall be liable to arrest, and upon conviction in the City Court of said City shall be fined not more than one hundred dollars, or imprisoned in the County Jail not more than six months, or both; provided, however, that any person who deems himself aggrieved by such order or orders of any of the Inspectors of the Department shall have the right of appeal to the Building Department for a hearing before the Board of Advisors, which hearing the said Department shall order and hold within at least three days of the service of the aforesaid order, at which time the said Board shall hear the parties in interest, inquire into the facts, and render such decision as to it seems meet and proper; but, pending such hearing and the rendition of said judgment or decision, all building operations and work complained of as aforesaid shall be suspended and held in abeyance, under the penalty hereinabove provided.

SEC. 13. Further, any person, persons, or corporation desiring to engage, or being engaged in the business of contracting and building, before receiving a license to do so (and no construction work shall be done by other than a licensed builder) shall file in the office of the Building Department a petition in writing, giving the name of the person, persons, firm, or corporation, and the place of business of said person, persons, firm, or corporation, petitioning to become licensed builders or contractors, and agreeing that he or they will abide by the rules and regulations of the Building Department and the City Ordinances, and furnishing evidence that he is or they are perfectly competent to carry on such construction work. Before receiving a license the applicant shall execute and deposit in the office of the Building Department a good and sufficient bond payable to the City to be approved by said Building Department, in the sum of $3,000 conditioned that said applicant will indemnify and save harmless the City and the Building Department of and from all accidents or dam-

ages caused by him or them in any work done by virtue of his or their said license. Said petition shall be accompanied by a license fee of 20 dollars, to be paid into the treasury of the City, whereupon said Building Department shall issue to said applicant a license to engage in the business of master builder or contractor, or master builders or contractors.

CHAPTER III

FIRE LIMITS

SEC. 14. The Council shall establish a line which shall be a limit about the most congested and important section of the City, and the blocks contained within these limits shall be known as the "Inner Fire Limits."

¶This section shall be within another and larger one similarly established by the Council, upon the recommendation of Building Department, City Engineer, and Fire Department, that shall be known as the "Outer Fire Limits."

¶The space between this outer line and the city's limits of jurisdiction shall be known as the "Boundary Limits."

SEC. 15. No person, firm, or corporation shall hereafter erect any building or addition to a building within the Inner Fire Limits, as the said limits now are or may hereafter be established, unless said building be of fireproof construction as provided in this Code.

¶No person, firm, or corporation shall erect, enlarge, elevate, alter, or otherwise change any building or addition to a building within the Outer Fire Limits, as the said limits are now or may hereafter be established, unless the outer walls and the covering of the roof be composed wholly of noncombustible materials, and the use of sheet metal for the covering of outside wooden walls of buildings within the Outer Fire Limits is prohibited. Nothing herein, however, shall be understood to prohibit the use of tar or asphalt and gravel, or slag and asbestos roofs, but such roofs must be approved by the Building Department.

SEC. 16. All exposed windows in the inner fire district, except windows facing on streets over thirty feet wide, shall be protected by standard,

fire-resisting shutters or by metal window frames and metal sash glazed with wire glass.

SEC. 17. Outside the Fire Limits when any brick, stone, or concrete building is to be erected of a class that could, under this Code, be constructed of wood, the Building Department is hereby authorized, empowered, and directed to allow reasonable modifications of this Code relating to brick, stone, or concrete buildings in consideration of incombustible material being used voluntarily for walls instead of wood.

SEC. 18. In the matter of what is and what is not combustible construction, as in all the terms used in this Code, it has been sought to use the simplest and plainest definitions, those understood and in common use in this vicinity. So also in the matter of construction, it is aimed to define construction, sizes of brick, measurements, and such matters that conform to common usage and custom and mode in vogue in this vicinity. But, in the case of any dispute, or if the Advisory Board itself be in doubt, then Kidder's Building Hand-Book will be the deciding authority as to all such disputed terms.

CHAPTER IV

QUALITY OF MATERIALS

SEC. 19. All materials shall be of quality suitable for the purpose for which they are intended to be used and conform to trade and manufacturers' standards. Each material must be free from imperfections whereby its strength or durability may be seriously impaired.

TESTS

¶The Building Department shall have the authority to reject materials which are unsuitable and below the usual standards, and may require tests to be made at the expense of the architect, engineer, builder, or owner to determine the strength of any structural materials.

¶In all such major tests prescribed in this Code the same shall be made by the National Bureau of Standards at Washington, D. C., or the Under-

writers' Laboratory at Chicago. Or, if these Laboratories be too busy to attend to the matter within the time required, the tests may be made by some State or private laboratory of recognized standing and proper equipment that may be recommended and approved in writing by either and the manner of making the test will be according to the instructions of said Bureau of Standards. All such tests are to be paid for by the owner or his engineer or manufacturer—in no case by the City—but shall be directed, called for, and, if necessary, supervised by the Building Department.

¶In case such materials or systems of construction have already been tested by either of these two laboratories, then the Department may accept its report in lieu of an additional or new test especially for the City.

BRICK AND STONE

SEC. 20. Brick shall be well burned and hard. When old bricks are used they shall be thoroughly cleaned. When the season will permit, bricks shall be wet before using.

¶No soft bricks shall be used in any part of a building exposed to the weather or in any internal or external piers, nor in any part of a wall where there is a greater height than 40 feet of wall above said brick. The bond of brick work shall be formed by laying one course of headers for at least every six courses of stretchers or the equivalent of such bonding. All stone and brick work over openings exceeding 4 feet in width shall be supported with stone or iron or concrete lintels of sufficient strength to carry the superimposed weights, excepting where such stone or brick work shall be supported with substantial stone or equally strong arches. All lintels supporting stone or brick work must bed on stone, brick, concrete, or iron of sufficient strength.

SEC. 21. Stone shall be sound and hard and of sufficient dimensions for its intended use.

SEC. 22. Sand used for mortar shall be clean, sharp grit sand free from loam, dirt, or organic matter.

SEC. 23. Lime shall be thoroughly burned quick lime of good quality and well slacked before using.

SEC. 24. Any natural cement which is a product of calcination of natural rock, such as Akron, Louisville, and other hydraulic cements and slag Portlands, will be classed as "natural cement."

SEC. 25. Standard Portland cement of commerce, either domestic or foreign, shall be capable of passing the requirements as set forth in the "Standard

Specification for Portland Cement," by the American Society for Testing Materials. The medium requirements for tensile strength for briquettes 1 inch square in section shall be as follows, and there shall be no retrogradation in the strength between the periods specified:

Neat Cement	Strength
24 hours in moist air	200 lbs.
7 days (1 day in moist air, 6 days in water)	550 lbs.
28 days (1 day in moist air, 27 days in water)	650 lbs.

¶For fireproofing and floor construction the highest grade of Portland shall be used. It shall be of uniform consistency and of such fineness that not more than ten per cent will be rejected by a sieve of twenty-five hundred meshes per square inch, and be subject to such other physical and chemical tests that the Building Department may require.

SEC. 26. A properly proportioned mixture of lime and sand—not more than three parts sand to one part unslacked lime—will constitute lime mortar.

SEC. 27. A properly proportioned mixture of cement and sand with lime added—not more than four parts sand to one part each of dry cement and slacked lime—will constitute lime and cement mortar.

SEC. 28. A properly proportioned mixture of cement and sand—not more than four parts sand to one of Portland cement, not more than three parts sand to one of Rosendale cement—will constitute cement mortar. The test for the same shall be as follows:

One part cement, 3 parts standard sand	Strength
7 days (1 day in moist air, 6 days in water)	175 lbs.
28 days (1 day in moist air, 27 days in water)	300 lbs.

SEC 29. Mortar for plastering shall be made as follows or equally well: The mortar shall be slacked, made into putty, and cooled before putting in the hair which must be well separated. One bushel of hair will be required for every three barrels of putty; one and one-half barrels of sand to one barrel of putty may be mixed for the first or scratch coat, after being thoroughly mixed as above. The said mixture must be stacked for at least three days before using. The said mortar shall be used on lath surfaces with a second coat of mortar in which are two and one-half barrels of sand to one barrel of putty and less hair.

¶Patent plasters may be used with the approval of the Department.

CONCRETE

SEC. 30. When the structural use of concrete is proposed, a specification stating the quality and proportion of materials and the methods of mixing

the same shall be submitted to the Building Department and approved by it before the work shall be carried on.

¶Concrete for foundations shall be made of at least one part cement to three parts of sand and five parts of clean broken stone, free from dirt and dust, of such size as to pass in any way through a 2-inch ring, or good clean gravel may be used in the same proportion as broken stone.

¶The ingredients of the concrete shall be thoroughly mixed to the desired consistency and the mixing shall continue until the cement is evenly distributed and the mass is homogeneous and uniform in color. Methods of measurement of proportions of the various ingredients, including water, shall be used, which will secure separate uniform measurement at all times.

¶Where the conditions will permit a machine mixer of a type which insures a proper mixing of the materials throughout the mass shall be used.

¶When it is necessary to mix by hand the mixing shall be on a. watertight platform and special precaution must be taken to turn the materials until they are homogeneous in appearance and color.

¶The materials must be mixed wet enough to produce a concrete of such consistency as will flow into the forms and about the metal reinforcement and which on the other hand can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar.

WOOD

SEC. 31. All timber and wood shall be of good sound lumber free from rot, large or loose knots, shakes, or any imperfections whereby the strength may be impaired, and be of such size and dimensions as the purposes for which the building is intended require.

STRUCTURAL IRON AND STEEL

SEC. 32. All structural wrought or cast iron or steel, in quality, in requirements of tests, in workmanship, and in assemblage and interconnections of shapes, shall be in accordance with the standard specifications of the Association of American Steel Manufacturers, as given in the hand-books of the respective standard manufacturers; provided that for buildings of skeleton-frame fireproof construction, the Building Department may, at any time, require the owner to engage recognized experts who shall supervise the mill, shop, and field work, and who shall file certified copies of their reports on the progress of the work for the approval of said Building Department; and no work shall be concealed or built upon until the Building Department has been furnished satisfactory proof that it is up to the accepted standard and properly painted or protected.

¶All wrought iron shall be uniform in character, fibrous, tough, and ductile.

It shall have an ultimate tensile resistance of not less than forty-eight thousand pounds per square inch, an elastic limit of not less than twenty-four thousand pounds per square inch, and an elongation of twenty per cent in 8 inches, when tested in small specimens.

¶Wrought iron shall be tested full sized as rolled when called for by the Building Department. Specimens not more than 1 inch in thickness should bend double when cold, without showing cracks or flaws.

¶All structural steel shall have an ultimate tensile strength of from fifty-four thousand to sixty-four thousand pounds per square inch. Its elastic limit shall not be less than thirty-two thousand pounds per square inch, and test specimens, ruptured in tension, must show a minimum elongation of not less than twenty per cent, with from fifty thousand to fifty-eight thousand pounds per square inch.

¶Cast steel shall be made of open hearth steel containing one-quarter to one-half per cent of carbon, not over eight one-hundredths of one per cent of phosphorus, and shall be practically free from blowholes.

¶Cast iron shall be of good foundry mixture, producing a clean, tough, gray iron.

¶The quality of the iron going into castings under specifications shall be determined by means of the "Arbitration Bar." This is a bar 1¼ inches in diameter and 15 inches long. Two sets of two bars shall be cast from each heat, one set from the first and the other set from the last iron going into the castings. Where the heat exceeds twenty tons, an additional set of two bars shall be cast for each twenty tons or fraction thereof above this amount. In case of mixture during the heat, one set of two bars shall also be cast for every mixture other than the regular one. Each set of two bars is to go into a single mould. The bars shall not be rumbled or otherwise treated, being simply brushed off before testing.

¶The transverse test shall be made on all the bars cast, with supports 12 inches apart, load applied at the middle, and the deflection at rupture noted. One bar of every two of each set made must fulfill the requirements to permit acceptance of the castings represented.

¶The bottom of the bar is $\frac{1}{16}$ of an inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask is to be rammed up with green moulding-sand, a little damper than usual, well mixed and put through a No. 8 sieve with a mixture of one to twelve bituminous facing. The mould shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test-bar shall not be removed from the mould until cold enough to be handled.

SEC. 33. All structural material of whatever nature shall be subjected to tests to determine its character and quality by methods established by the authorities already prescribed; the tests shall be made under the supervision of the Building Department if it deems that supervision necessary or it may direct the owner to file with it a certified copy of the results of such tests as they may direct. No new structural material shall be used in any structure until it has been properly tested and found to fulfill the minimum conditions and tests required by this Code for materials used for like purposes.

SEC. 34. The stresses used in materials hereafter to be used in construction shall be the calculated stresses due to their "dead load" plus the applied "live load." The allowable factors or units of safety or the dimensions of each piece or combination of materials required in a building or structure, if not given in this Code, shall be ascertained by computation according to the rules prescribed by the standard modern authorities on strength of materials, applied mechanics, and engineering practice, provided that the Building Department may, and in cases of trussed or reinforced concrete buildings two or more stories high, shall require the owner or architect or engineer to submit a certified copy of such computation or strain sheets for examination and approval with the application for the Building Permit.

CHAPTER V

FACTORS OF SAFETY

SEC. 35. In computing the working stresses in the framing of any building, unless the safe loads are prescribed in this Code, the following factors of safety shall be used, these factors to be increased where there is a vibrating load:

¶For wrought iron or steel subject to compression or tension or transverse strains. 4

¶For cast iron subject to tension or transverse strains. 10

¶For cast iron subject to compression for plates and columns of ordinary or short length—according to the uniformity of the thickness of shell . . 6 to 8

¶For cast iron long columns—according to the uniformity of the thickness of shell . . . . . 8 to 10

¶For timber compressions in short columns or posts 4

¶For timber subject to tension and transverse strain 6

¶For timber in long columns or posts 5

¶For natural or artificial stone or masonry or concrete 10

¶For framed structures composed of two or more pieces of the same material, or a combination of two or more pieces of different materials, such as frames of all kinds, brackets, cantilevers, trusses, and arched floors or reinforced concrete floors combined with metal girders, beams or channels, under ordinary loading of buildings 4

¶For framed structures as above exposed to vibrations of machinery or trucking or shocks, or exposed to the action of the elements 5

¶For floors or arch construction of brick, concrete, or tile, or similar bearing parts between beams. 6

¶For floors of reinforced concrete construction or concrete and tile, or reinforced tile, or similar bearing parts between beams. 5

¶For iron or steel in latticed or open worked columns or latticed beams or girders when solidly filled or encased in concrete extending at least 2 inches beyond the outer edges or faces of the structural members (with no allowance for the concrete) 3

SEC. 36. Every temporary support under any structure, wall, girder, or beam, during the erection, finishing, alteration, or repairing of any building or structure or any part thereof, shall be of sufficient strength to safely carry the load to be placed thereon, allowing a factor of safety of not less than five.

¶During the construction or alteration of any building or structure, no material entering into such construction or alteration shall be placed on any floor or roof of any greater weight than the live load that each such floor or roof is intended to safely sustain when the building or structure is completed.

CHAPTER VI

CALCULATION OF STRESSES

EARTH AND FOUNDATION LOADS

SEC. 37. Sound, natural earth shall not be loaded to more than the following in tons per square feet:

Gravel and coarse sand, well compacted or hard pan	6 tons
Hard rock	20 "
Fairly hard rock	6 "
Dry, hard clay or fine sand	4 "
Moderately dry clay or moderately compact sand	2 "
Soft sand or clay or undisturbed alluvial soils	1 ton

¶No foundation shall be started on filled ground until proper tests have been made under a skilled engineer and permit granted by the Building Department. When a doubt arises as to the safe sustaining power of the earth upon which a building is to be erected, the Building Department may order borings to be made, or direct that the sustaining power of the soil be tested by and at the expense of the owner of the proposed building.

SEC. 38. Allowable safe load in tons per square foot, Table I.

TABLE I

Foundation Loads

Laid in Mortar	Lime	Lime and Portland Cement	Hydraulic Cement	Portland
Common Kiln Run Brick	6	8	10	13
Common Selected Hard Brick	6	10	12	16
Hard Pressed Hydraulic or Vitrified Shale or Paving Brick	6	12	14	18
Stone (Rubble, Irregular Bonded)	4	5	7	10
Stone (Ashlar or Block with full beds)	6	12	15	20
Concrete (Cement 1, Sand 2, Stone 4)			8	16
Concrete (Cement 1, Sand 2, Stone 5)			6	14
Stone, Rubble, Coursed, and Well-bonded	6	7	9	11

INACTIVE AND LIVE LOADS

SEC. 39. In columns, girders, timbers, walls, and materials, the stresses and loads allowed shall be those accepted in general practice, recognized by the best authorities, and defined by Kidder or such accepted textbooks. So in the live loads calculated for floors, stairs, galleries, etc., the minimum generally accepted shall obtain and the different classifications shall be according to Kidder or such accepted text books, provided, however, that no floor or stair or gallery or roof shall be calculated for less than 40 pounds live load per square foot of surface.

¶Also the architect or engineer of any building may be required to present his calculations for such stresses, loads, etc., in such form that they may be readily checked by the Department, and the work shall not proceed until the Department approves of such loads, etc.

¶Wherever the load may be a shifting or a moving or a vibrant one—for example, in machine shops, factories, drill halls, or churches—or wherever a crush of people may occur, the live loads shall be calculated at 33 per cent additional live load over and above an inactive live load such as in a warehouse, a home, or a museum.

SEC. 40. The Building Department shall estimate the live loads allowable under any construction that may be proposed; these loads shall be marked upon the plans and the owner of the building shall conspicuously label and post these same loadings in his building. And at no time shall the floors be loaded in excess of that allowed maximum. If the building is to be changed as to its nature of occupancy and additional loads be desired, then the floors shall be reinforced under the direction of the Department.

¶The Department shall also, as rapidly as possible, determine the floor loads allowable in all existing buildings, where in its belief overloading may now obtain, or where it is evident that such overloading might result disastrously to life and adjacent property. The buildings so examined shall be labeled in the same manner as the new ones, as to allowable loads, and such floors shall not be overloaded under the penalties provided for other similar offenses. The Building Department shall have police authority for the enforcement of this and all other clauses of this Code, and for all infractions of the same it shall cite the owner or builder or their representatives before the proper Court, there to be dealt with as that Court shall decree imprisonment or fine or both as the importance of the offense shall, in the opinion of the Court, justify.

¶In such prosecutions or in any defense the Department may be called upon to make, it shall have the assistance, help and advice of the City Attorney.

CHAPTER VII

EXCAVATIONS

SEC. 41. All excavations for buildings shall be made at least 9 inches beyond the line of masonry to permit of inspection and shall be properly guarded and protected by the person, persons, or corporations causing the same to be made, so as to prevent the same from becoming dangerous to life and limb, and shall be sheath piled where it may be necessary, or by some other method approved by the Building Department to prevent the adjoining soil from caving in, by reason of its own weight or by reason of any weight that may rest upon it.

SEC. 42. Whenever any excavation is made on land adjoining a building, the owner of the land upon which such excavation is made shall shore up, protect, and take every precautionary measure to protect and save from injury or harm all footings, foundations, walls, or parts thereof, or any part of the building, which is liable to be injured by reason of such excavations, provided the depth of such excavation exceeds 6 feet below grade. If such excavation does not exceed 6 feet, then any such expense shall be borne by the owner of such building.

SEC. 43. Plans filed with the Building Department shall be accompanied by a statement of the character of the soil at the level of the footings found by test-borings.

SEC. 44. When buildings to be erected or altered front on business thoroughfares and in congested business districts the Building Department may require that sidewalk traffic be maintained without interruption by means of elevated or covered sidewalks, and such covering shall be strong enough to protect passers-by from falling material, and everywhere all temporary inclosing fences and sidewalks, etc., shall be kept clean and all traffic shall be interfered with as little as possible. In all these matters the orders of the Department must be promptly obeyed. Sufficient lights and guards shall be maintained at all such obstructions or excavations. The street proper is to be kept clear, save the temporary sidewalk, 3 feet wide, that may be built beyond the curb line.

CHAPTER VIII

FOUNDATIONS AND FOOTINGS

SEC. 45. Every building except buildings erected upon solid rock, shall have foundations of brick, stone, steel, iron, or Portland cement concrete, laid not less than 4 feet below the surface of the earth on solid ground, on level surface of rock, or upon wide footings, reinforced concrete beds, piles, or ranging timbers, when solid earth or rock is not found. Piles intended to sustain a wall, pier, or post shall be driven to a solid bearing, if practical to do so, and the number of such piles and their dimensions shall be sufficient to support the superstructure proposed.

SEC. 46. The Building Department shall be notified of the time when test piles shall be driven. The tops of all wooden piles shall be cut off below the lowest water line. When required, concrete shall be rammed down in the interspaces between the heads of the piles to a depth and thickness of not less than 12 inches and for 1 foot in width outside of the piles.

SEC. 47. Where ranging and capping timbers are laid on piles for foundations, they shall be of hard wood not less than 6 inches thick and properly joined together, and their tops laid below the lowest water line.

SEC. 48. Where metal is incorporated in, or forms part of, a foundation it shall be thoroughly protected from any rust by asphaltum, concrete, or by such materials and in such manner as may be approved by the Building Department. When footings of iron or steel which form columns are placed below the water level they shall be similarly coated and inclosed in concrete for preservation at against rust.

SEC. 49. When foundations are carried down through earth by piers of stone, brick, or concrete in caissons, the loads and mode of construction and manner of doing shall first be approved by the Building Department and, if need be, this or any other specially important work may be permitted only under the superintendence of the Department.

SEC. 50. Foundation walls shall be built of stone or brick with cement mortar, or of Portland cement concrete, except foundations for frame buildings and private stables and for buildings not more than two stories in height, which may be built with lime and cement mortar. If built of Portland cement concrete, they shall be at least 4 inches thicker than the wall next above them in a depth of 12 feet below the curb level and for every additional 10 feet or part thereof deeper, they shall be increased 6 inches in thickness. The footing or base course shall be of stone or concrete, or both, or of concrete and stepped-up brickwork of sufficient thickness and area safely to bear the weight to be imposed thereon.

SEC. 51. If the footing or base course be of concrete, the concrete shall not be less than 12 inches thick. If of stone, the stone shall not be less than 16 inches by 24 inches and at least 6 inches in thickness for walls, and not less than 8 inches in thickness for piers, columns, or posts. The footing or the base course, except under framed buildings, whether formed of concrete or stone, shall be at least 8 inches wider than the bottom width of walls, and at least 6 inches wider on all sides than the bottom width of the said piers, columns, or posts. If the superimposed load is such as to cause undue transverse strain on a footing projecting 6 inches, the thickness of such footing shall be increased so as to carry the load with safety, by adding extra course or courses of above dimensions. All base stones shall be well bedded and laid crosswise edge to edge.

¶If stepped-up footings of brick are used in place of stone above the concrete, the offsets, if laid in single courses, shall not exceed 1½ inches, or if laid in double courses, shall not exceed 3 inches, the first course of brickwork being set back one-half the thickness of the concrete base, so as properly to distribute the load to be imposed thereon.

SEC. 52. If, in place of a continuous foundation wall, isolated piers are to be built to support the superstructure, where, in the opinion of the Build-

ing Department, the nature of the ground and character of the building make it necessary, inverted arches resting on a proper bed of concrete, both designed to transmit with safety the superimposed loads, shall be placed between the piers. The thrust of the outer piers shall be taken up by suitable wrought iron or steel rods and plates.

SEC. 53. Grillage beams of wrought iron or steel resting on a proper concrete bed may be used. Such beams must be provided with separators and bolts, inclosed and filled solid between with concrete, and of such size and so arranged as to transmit with safety the superimposed loads.

SEC. 54. All stone walls 24 inches and not less than 18 inches in thickness shall have at least one header extending through the wall in every 3 feet in height from the bottom of the wall, and in every 3 feet in length; and if over 24 inches in thickness, shall have one header for every 6 superficial feet on both sides of the wall, laid across each other to bond together, and running into the wall at least 20 inches. All headers shall be at least 12 inches in width and 6 inches in thickness and shall consist of good flat stones.

¶No stone shall be laid in such walls in any other position than on its natural bed. No stone shall be used that does not bond or extend into the wall at least 6 inches. Stones shall be firmly bedded into cement mortar and all spaces and joints thoroughly filled.

SEC. 55. External retaining walls shall be constructed of sufficient thickness to safely support the outside pressure when earth embankments are adjacent to any foundation or curb wall and shall be properly coated, cemented, or otherwise protected against water seepage.

¶Proper damp courses shall be provided in all foundation walls and, likewise, proper provision of open drains outside the wall and covered with broken stone or other such expedient to carry off surface water and prevent wet collars.

SEC. 56. In all cases a connection with the street sewer where the same exists shall be established before beginning the work of laying foundations. Before the walls of buildings are carried up above the foundation walls, the cellars shall be connected through drains and catch basins with the street sewer. Should there be no sewer in the street, or if the cellars are below the sewer or ground-water level, then provisions shall be made to prevent water accumulating in the cellars to the injury of the foundations or the occupancy of the basement cellar.

CHAPTER IX

WALLS, PIERS, AND PARTITIONS

SEC. 57. Walls, piers and partitions will be proportioned in thickness, length, and frequency to the loads they have to carry, the class of building, the limits in which that building is erected, and the materials used. And the plans will state specifically the nature and class of building, the floor loads and all such data in order that the Building Department may check up these figures and approve of the thicknesses of such walls, etc., as well as of all else proposed; or, disapproving, may direct how the work shall be done to receive such approval.

SEC. 58. For separate private dwellings or private stables 8-inch brick walls or their equivalent in other materials, may be used for one story, providing no wall is more than 30 feet long, without a break or buttress, and not over 11 feet high and not span more than 18 feet. 8-inch brick walls may be used for small stores, the walls of which are not more than 30 feet long without break or buttress, nor more than 11 feet high nor for spans of more than 18 feet. All 8-inch brick walls must be built with Portland cement mortar.

SEC. 59. Where two stories of frame construction are erected over one story of brick construction, the brick walls shall not be less than 12 inches thick or their equivalent in other materials.

SEC. 60. The walls of all buildings, other than frame or wood, shall be constructed of stone, brick, hollow tile, Portland cement concrete, iron or steel, or, if approved by the Building Department, other hard, incombustible material, and the several component parts of such buildings shall be as herein provided.

SEC. 61. All buildings shall be inclosed on all sides with independent or party walls or piers and incombustible sliding or other doors or shutters, or with metal frames and wired glass or equally fire-resisting inclosures, subject, of course, to the approval of the Building Department.

SEC. 62. The walls and piers of all buildings shall be properly and solidly bonded together with close joints filled with mortar. They shall be built to a line and be carried up plumb and straight.

SEC. 63. The walls of each story shall be built up the full thickness to the top of the beams above.

SEC. 64. Walls or piers, or parts of walls and piers, shall not be built in freezing weather, unless the brick and mortar be heated.

SEC. 65. When walls are more than 25 feet apart, 4 inches shall be added for every succeeding interval of 10 feet or part thereof of increase of distance between them without intermediate division walls or rows of column and girder supports.

SEC. 66. When any horizontal section of wall shows more than 25 per cent reduction of area on account of flues, openings, and recesses, 4 inches shall be added for every succeeding interval of 10 per cent or part thereof of reduction, provided that, in walls of uniform thickness, such reduction does not exceed 55 per cent of the whole, or, in masonry pier construction, not more than 70 per cent for each bay.

SEC. 67. When the floors of a building of an established height are to be loaded heavier than the maximum given in the tables of permissible loads, the thickness of walls shall be proportionately increased.

SEC. 68. All buildings over 100 feet in depth, without a cross-wall or proper piers or buttresses, shall have the side or bearing walls increased 4 inches more than is actually required for load sustaining.

SEC. 69. All party or division walls of a less thickness than 12 inches shall be corbeled, not less than 3 inches on sides, to receive the floor joists; or instead of corbeling, approved malleable iron or steel joist-hangers may be used.

SEC. 70. Where it appears that extra or additional stress shall come upon any wall or pier extra provision shall be made for carrying the same by additional thickness of walls, or additional size of pier, or the addition of proper pilasters.

SEC. 71. The inside 4 inches of any wall may be built of hard-burnt hollow brick, properly tied and bonded by means of full header courses every sixth course into the walls, and of the dimension of the ordinary bricks.

SEC. 72. Where hollow tiles are used as lining or furring for walls they shall not be included in the measurement of the thickness of such walls. But where terra cotta blocks are so used they shall be allowed their proportionate value in carrying loads.

SEC. 73. In all walls that are built hollow or in two sections the same quantity of stone, brick, or concrete shall be used in their construction as if

they were built solid, as in this Code provided, and no hollow wall shall be built unless the parts of same are connected by proper ties, either of brick, stone, or iron, placed not over 24 inches apart.

SEC. 74. No recess or chase for water, soil, steam, or other pipes shall be made in any exterior or in any other bearing wall to more than one-third of its effective thickness, and the recesses around said pipe or pipes shall be filled with solid masonry, or plastic incombustible material, after the pipes are in place, for the space of 1 foot at the top and bottom of each story. No recesses shall be made in any exterior or other bearing wall less than 12 inches thick, and no continuous vertical recess other than flues in stacks shall be nearer than 5 feet to any other recess.

SEC. 75. No channeling shall be done in walls which are less than 12 inches thick except for small gas pipes and wire conduits. Recesses for stairways or elevators may be left in the foundation or cellar walls of all buildings, but in no case shall the walls be of less thickness than the walls of the third story, unless reinforced by additional piers with iron or steel girders or iron and steel columns and girders, securely anchored to walls on each side.

¶No horizontal chase shall be more than 4 feet in continuous length, unless the wall be made proportionately thicker.

SEC. 76. All structures exposed to wind shall be designed to resist a horizontal wind pressure of thirty pounds for every square foot of surface thus exposed, from the ground to the top of same including the roof, in any direction. In no case shall the overturning moment due to wind pressure exceed 75 per cent of the moment of stability of the structure. In all structures exposed to wind, if the resisting moments of the ordinary materials of construction, such as masonry, partitions, floors, and connections, are not sufficient to resist the moment of distortion due to wind pressure, taken in any direction on any part of the structure, additional bracing shall be introduced to make up the difference in the moments.

¶In calculations for wind bracing, the working stresses set forth in this Code may be increased by 50 per cent. In buildings under 100 feet in height, provided the height does not exceed four times the average width of the base, the wind pressure may be disregarded.

SEC. 77. It shall be unlawful to erect, construct, or build any rear, front, party, division, or partition masonry wall upon wooden girders, rafters, or lintels, or to support any such wall by any wooden support whatever; but all such supports shall be of iron, brick, or stone and shall rest on sufficient stone or metal bearing blocks, and all metal supports shall be

kept rustless by being well cemented, painted, or otherwise protected from moisture.

SEC. 78. Openings for doors and windows in all buildings shall have good and sufficient arches of stone, brick, terra cotta, or concrete, well built and keyed with good and sufficient abutments; or lintels of stone, iron or steel, terra cotta, or concrete of sufficient strength, which shall have a bearing at each end of not less than 5 inches on the wall.

SEC. 79. All masonry arches shall be capable of sustaining the weight and pressure which they are designed to carry, and the stress at any point shall not exceed the working stress for the material used, as given in this Code.

SEC. 80. Tie rods shall be used where necessary to secure stability.

SEC. 81. Walls heretofore built or used as party walls, whose thickness at the time of their erection was in accordance with the requirements of the then existing laws, but which are not in accordance with the requirements of this Code, may be used, if in good condition, for the ordinary functions of party walls, provided the height of the same be not increased and that the load be not more than they can safely carry. In case additional height or load-carrying is required, then the said party wall or any other wall shall be properly strengthened, reinforced, or braced by additional thickness, columns, or other approved method.

SEC. 82. Any building, the erection of which was commenced in accordance with specifications and plans submitted to and approved by the Building Department prior to the passage of this Code, if properly constructed—with a reasonable factor of safety, though it be not as great a one as is contemplated by this Code—and in safe condition, may be completed, or built upon in accordance with the requirements of the law, as to thickness of walls, in force at the time when such specifications and plans were approved. The Building Department is to be the sole judge as to what may or may not be done in such contingency.

SEC. 83. In no case shall any wall or walls of any building be carried up more than one story in advance of any other wall, except by permission of the Building Department. And this prohibition shall include the inclosure walls for skeleton buildings.

SEC. 84. All exterior piers shall be anchored to the beams or girders on the level of each tier.

SEC. 85. All exterior piers, except of fireproof buildings, on the lot line, and division and party walls over 15 feet high, shall have parapet or coping

walls, carried at least 18 inches above the roof, and shall be coped with incombustible material. The front and rear walls, if facing on the street, alley, or open space, may have the parapet wall omitted. Open balustrades shall not be placed above the cornice line of any building unless they are built of incombustible material, nor shall the top rail of such balustrades be over 5 feet above the roof line. Parapet walls and party or division walls shall extend at least 2 feet above flat roofs.

SEC. 86. In all walls furred with wood the brick work between the ends of the wood beams shall project the thickness of the furring beyond the inner face of the wall for the full depth of the beams.

SEC. 87. The height of stories for all given thicknesses of walls except by special permit, shall not exceed the following:

First story.....16 feet in the clear
Second story.....14 feet in the clear
Third story.....12 feet in the clear
Fourth and upper stories.....11 feet in the clear

¶And if any story exceeds the foregoing heights, the walls of any such story and all walls below that story shall be increased proportionately.

SEC. 88. Stone, cement block, or terra cotta facing shall be not less than 4 inches in thickness at any place, and shall be securely anchored to the brick backing at least every 2 feet vertically and horizontally. The facing walls shall not be counted as a part of the thickness of brick walls, unless the average thickness of facing is thoroughly bonded into the walls, in which case one-half the average thickness of facing shall be allowed in calculating thickness of wall.

SEC. 89. 8-inch curtain walls of brick, hollow tile, or concrete will be allowed in all steel framed buildings (except in party walls) between piers or steel columns 16 feet on centers and not over 12 feet high. Party walls in such buildings must not be less than 12 inches thick at any story.

SEC. 90. In all apartment houses, the dividing walls or partitions between the apartments provided for each family, where not separated by a hall or stairway, shall be made of incombustible material. In the absence of definite subdivisions between the apartments of different families, eight rooms shall be counted as the equivalent of one apartment. In all buildings, not of fireproof construction, there shall be, for every eight rooms in any one story, dividing walls—or partitions of incombustible material separating the rooms from the contiguous spaces—solid walls, or walls with openings, if the latter be provided with self-closing fire doors.

SEC. 91. In double houses or houses in block for the dividing walls shall be of brick or other incombustible material, extending from the cellar to 1 foot above the roof, and 2 feet above flat roofs, excepting in case of steep roofs of double houses, where division walls shall be carried to under side of roof boards.

SEC. 92. When brick walls surround stairways, elevator shafts, shaving pits, and light shafts, they shall not be less than 8 inches thick, but no such, or any other, 8-inch wall shall be built more than 20 feet high without lateral support or anchorage.

SEC. 93. In calculating the strength of isolated piers or divisions forming portions of walls, the least dimensions shall be considered in determining the loads which such piers may carry. If outside walls are of pier construction, the piers shall be graded in size according to weights to be carried, but not less than 16 inches thick for the upper story.

¶Such piers shall have a width of 24 inches for an 8-foot bay, measuring from center to center of pier, and shall increase as the width of the bay is increased. Curtains or panels between piers shall be at least 8 inches thick, and of brick or the equivalent thereof.

SEC. 94. No isolated brick or other pier whose height exceeds ten times its least dimensions shall be built, and any such pier where receiving concentrated loads shall have suitable bearing blocks of stone, or iron, or other such solid, so proportioned as properly to distribute the load to come upon it.

SEC. 95. In case piers are faced with pressed brick or other facing, they shall be so laid as to have proper bearings of mortar under each course, so that the strength of the pier may be fully maintained on all sides; the central part of the pier shall be laid in Portland cement.

¶In blocks of frame houses the dividing partitions, between three houses, may be built with 5-inch studs, filled in solid with 4 inches of brickwork laid in mortar, or with other incombustible material, carried to the under side of the roof boards. Such dividing partition shall rest on a brick, concrete, or stone wall in the cellar. Where it is impractical to build a partition with masonry filling, and at the discretion of the Building Department, a 4-inch stud partition filled in solid with mineral wool, held in position by blocks every 3 feet in height, and plastered on both sides with hard plaster on metal lathing, may be used for a fire-retarding dividing partition. In blocks of more than three houses there shall be a solid brick, or other fire wall extending above the roofs, as described for fire walls, at every third house.

¶Openings in the fire or party walls of buildings shall in no case exceed 8 feet in width, or 10 feet in height, and above each such opening there shall be a curtain wall, between the top of the opening and the ceiling line, of at least 3 feet. The opening shall be provided with approved automatic self-closing, standard fireproof doors on both sides of the wall and such openings may only be made in completed buildings with the permission of the Building Department.

SEC. 96. Public stair-halls in apartment blocks or tenement buildings shall be inclosed by brick walls or walls of incombustible materials of equal fire-resisting capacity, and openings to separate apartments or tenements shall be by approved fire doors and no transoms shall be allowed. Such fireproof stairs shall lead directly to the street and be inclosed at the street level with similar fire walls with fire doors to the apartments or stores on the first floor, the object being to have an absolutely clear, direct, and fireproof exit from the top story to the street.

¶In every building hereafter erected or altered, all walls or partitions forming interior light or vent shafts, shall be constructed of brick or of other incombustible materials, except that where approved by the Building Department, in inferior buildings in the outer limits, they may be constructed of 4-inch studs, filled in solid with fireproofing material or plastered on both sides on metal lathing and always with masonry fire stops at each floor, and shall extend 2 feet above the roof.

SEC. 97. The windows in said shafts shall have metal frames and sash, and wire glass. Ceiling lights under shafts shall have wire glass in metal frames. Where shafts start above the first floor, they shall be supported by steel or concrete beams.

SEC. 98. Walls of dumb-waiters, clothes chutes, or other similar shafts must be built of or lined with incombustible material as directed for light and vent shafts and shall be provided with an approved metal-clad door at each opening.

SEC. 99. All receptacles for ashes, garbage, waste paper, etc., shall be of galvanized iron, brick or other incombustible material. When the ash or other such pit is located in a basement or cellar, it shall have brick walls at least 8 inches in thickness, and, if the floor over the same is of wood, such pit shall be covered over with either brick, tile-arching, stone, or concrete, not less than 4 inches thick with 4 inches of air space between the covering of pit and the ceiling, except for pits built directly under the trimmer arches of hearths.

¶No person shall store ashes on a wooden floor or in close proximity to any woodwork whatever.

SEC. 100. Bake ovens shall rest on solid foundations or steel beams; the sides and ends shall be at least 2 feet from any woodwork and the crown or arch at least 4 feet from ceilings that have wood joists. The hearth in front of all bake ovens shall extend at least 3½ feet beyond the face thereof and all woodwork over ovens shall be protected by plastering or by metal.

SEC. 101. Shaving pits in all factories where woodworking machinery is used shall be constructed of brick, stone, or other incombustible material and shall be separated from the boiler room by standard fire doors with bottom sill at least 12 inches above the floor of the boiler room. All such factories shall have metal chutes leading to said shaving pits from each wood-working machine.

SEC. 102. Dry kilns shall be constructed of brick or of other incombustible materials.

SEC. 103. All smoke houses shall be of fireproof construction, with brick walls, iron doors, and brick or metal roof.

¶An iron guard shall be placed over and not less than 3 feet above the grate, and the hanging rails shall be of iron and an iron grating shall be placed under the first row of hanging rails, and be not less than 8 feet above the floor of the fire-pit.

¶The walls of all smoke houses shall be built at least 3 feet higher than the roof of the building in which they are located, and shall be not less than 12 inches in thickness and be coped with stone or its equivalent.

SEC. 104. All walls, ceilings, and partitions inclosing drying rooms, when not made of fireproof material, shall be wire-lathed and plastered, or covered with metal, tile, or other hard incombustible material.

CHAPTER X

BOILERS, OVENS, AND HEATING APPARATUS

SEC. 105. All boilers, furnaces, fireplaces, ovens, and all other heating apparatus mentioned in this chapter shall be properly connected with a flue, chimney, or stack as direct and within the shortest distance possible.

SEC. 106. Approved temporary heaters for use during the erection of buildings shall be placed upon a layer of brick or a bed of sand 4 inches thick with legs resting on brick, and shall not be set within 5 feet of any woodwork and shall be protected with a sheet-iron pan underneath, projecting at least 6 inches beyond the sides of the heater.

SEC. 107. No brick-set boiler for the generation of hot water, or steam for heating or power, or any portable power boiler or engine over 10 horsepower, shall be placed on any wood or combustible beam or floor.

SEC. 108. Wood or combustible floor and beams under and not less than 3 feet in front and 1 foot on the sides of all portable boilers shall be protected by a suitable brick foundation of not less than two courses of brick well laid in mortar on sheet iron or asbestos board; the said sheet iron or asbestos shall extend at least 24 inches outside of the foundation at the sides and front. Bearing lines of brick, laid on flat with air spaces between them, shall be placed on the foundation to support a cast-iron ash pan of suitable thickness on which the base of the boiler shall be placed, and shall have a flange, turned up in the front and on the sides, 4 inches high. Said pan shall be in width not less than the base of the boiler, and shall extend at least 2 feet in front of it.

¶If a boiler is supported on a cast-iron base, with the bottom of required thickness for an ash pan, and is placed on bearing lines of brick in the same manner as specified for an ash pan, the ash pan shall be placed in front of the said base and shall not be required to extend under it.

¶All wood ceilings and beams over and up to a distance of not less than 4 feet of all boilers shall be shielded with plaster on metal-suspended ceiling or other equally good protection. The distance from the top of the boiler to said shield shall be not less than 12 inches.

¶Brick or other fireproof walls shall surround the boiler room.

SEC. 109. Boiler and fuel rooms and smoke houses, which may hereafter be constructed, shall be located not less than 8 feet distant from any other building and shall be built throughout of incombustible material. All openings to such boiler and fuel rooms and smoke houses, if same are located within 30 feet of any other building, shall have shutters and doors of metal or wood covered with metal on both sides and edges.

¶No boiler for the generation of more than 10 horse-power shall be placed in any frame building. If existing boiler rooms are within dangerous distance (30 feet for 250 H. P., and 20 feet for 75 H. P., and 8 feet for 10 H. P.) of other buildings, then those boiler or fuel or smoke rooms, must at once be made fireproof.

¶Boiler and fuel rooms when constructed in buildings, shall be separately inclosed in brick walls so arranged that all openings between them and other parts of the building will be securely closed with automatically closing fire doors and it will be a punishable offense to ever block or fasten any such or other automatically or self-closing fire door open.

SEC. 110. If any question should arise relating to boiler rooms, fuel rooms, and rooms containing gas or gasoline engines, for which there is no provision in this Code, the Building Department shall have, as in all other cases of doubt, lack of specific requirements or conflicting requirements, full power to act, and its decision in the matter shall be of the same effect as if that special requirement were contained in this Code, and the same will be made thereto as an amendment.

SEC. 111. All brick-set, hot-air furnaces shall have two covers, with an air space of at least 4 inches between them; the inner cover of the hot-air chamber shall be either a brick arch or two courses of brick laid on galvanized iron or tin, supported on iron bars; the outside cover, which is the top of the furnace, shall be made of brick or metal supported on iron bars and so constructed as to be perfectly tight, and shall be not less than 12 inches below any combustible ceiling or floor beams, that, in turn, must be protected with plaster on wire lath or sheet asbestos and for a space at least 3 feet larger than the furnace.

¶The walls of the furnace shall be built hollow in the following manner: one inner and one outer wall, each 4 inches in thickness, properly bonded together with an air space of not less than 2 inches between them.

SEC. 112. All portable hot-air furnaces shall have a double cased jacket of not less than No. 26 iron from the base to the top of casting, with an air space of at least 1 inch between, and shall be placed at least 2 feet from any wood or combustible partition or ceiling and these protected by a metal or asbestos or equivalent shield.

¶Wood floors under all portable furnaces shall be protected by two courses of brick work well laid in mortar on sheet iron. Said brick work shall extend at least 2 feet beyond the furnace in front of the ash pan and lower course bricks shall be spaced so as to allow ventilation.

SEC. 113. The cold-air boxes of all hot-air furnaces shall be made of metal, brick, or other incombustible material, for a distance at least 10 feet from the furnace, and shall be so constructed as to be kept free from dust, and that they may be cleaned out, and shall be kept clean.

SEC. 114. In cases where hot water, steam, hot air, or other heating appliances or furnaces are hereafter placed in any building, or flues or fireplaces are changed or enlarged, due notice shall first be given to the Building Department by the person or persons placing the said furnace or furnaces in said building, or by the contractor or superintendent of said work, that proper inspection be made and permit issued.

SEC. 115. Where a kitchen range is placed within 6 inches of a wood wainscot or wood partition, the said woodwork shall be shielded with metal, asbestos, or equivalent protection from the floor to the height of not less than 2 feet higher than the range.

¶All ranges on wood or combustible floors and beams, that are not supported on legs and have ash pans 3 inches or more above their base, shall be set on zinc, brick, or cement foundations.

¶No range shall be placed against a furred wall.

¶All wood ceilings over all large ranges such as in hotels and restaurants etc., shall be guarded by metal hoods placed at least 9 inches below the ceiling.

¶A ventilating pipe connected with a hood over a range shall be at least 9 inches from all lath and plaster or woodwork and shielded. If the pipe is less than 9 inches from lath and plaster and woodwork, then the pipe shall be covered with ½ inch of asbestos plaster or other incombustible covering. No ventilating pipe connected with a hood over a range shall pass through any floor unless protected.

SEC. 116. Laundry stoves on wood or combustible floors shall have zinc or a course of brick, laid on metal, on the floor under and extended 24 inches on all sides of them. All stoves for cooking and heating purposes shall be properly supported on iron legs resting on the floor 1 foot from all lath and plaster or 2 feet from woodwork; if the lath and plaster or woodwork are properly protected by a metal or asbestos shield, then the distance shall be not less than 1 foot. A metal shield shall be placed under and 12 inches in front of the ash pan of all stoves that are placed on wood floors.

SEC. 117. All low gas stoves shall be placed on iron stands, or the burners shall be at least 6 inches above the base of the stove, and metal guard plates placed 4 inches below the burners and all woodwork under them shall be covered with metal. Open gas stoves shall be isolated in the same manner as provided for stoves; if properly air insulated within themselves, they shall be placed 2 feet distant from all unprotected woodwork, or 1 foot from plastered stud partitions.

¶The use of gas burners or heaters, located in a floor system under an open register, or on the outside of the firepot of any hot-air furnace, in which the products of combustion are allowed to escape into a room is hereby prohibited, and all such burners or heaters so located shall be removed within forty days after the passage of this Code. All gas ranges and gas stoves shall have vent pipes of suitable size, connected with flue.

SEC. 118. No gas log, gas grate, or other gas fireplace heater shall be installed in any building except in a brick fireplace connected with a chimney flue. No gas light or other burner shall be nearer than 2 feet to any wood or plaster on wood ceiling unless the burner is shielded with suitable mica or other deflector, and in no case will a wall bracket for gas or oil or other flame light be permitted less than 2 feet away from the window or external door, and all such brackets, anywhere, must have the gas flame at least 12 inches distant from wall.

SEC. 119. All core and annealing ovens, or any portable smelting furnaces, shall be set on incombustible hearths with an air space of at least 5 inches between hearths and the bottom of such ovens or furnaces. The construction of hearths and protection of surrounding woodwork shall be the same as prescribed for portable boilers or hot-air furnaces.

CHAPTER XI

STOVE AND SMOKE PIPES

SEC. 120. All stone or brick hot-air flues and shafts shall be lined with tin, galvanized iron, or burnt clay pipes, or cemented with a heat-proof, non-cracking cement.

SEC. 121. No wood casing, furring, or lath shall be placed against or cover any smoke flue or metal pipe used to convey hot air or steam.

SEC. 122. No stove pipe shall be placed nearer than 9 inches to any lath and plaster or board partition, ceiling, or any woodwork.

¶Smoke pipes of large laundry stoves, of large cooking stoves, and of furnaces shall not be less than 15 inches from any woodwork, unless they are properly guarded by metal shields; if so guarded, such pipes shall not be less than 9 inches distant.

SEC. 123. No smoke pipe shall pass through the wooden roof of any building unless a special permit be first obtained from the Building Department for the same. If a permit is so granted, then the roof through which the smoke pipe passes shall be protected by means of galvanized iron ventilated thimble of the following dimensions: In case of a stove pipe, the diameter of the outside guard shall be not less than 12 inches and the diameter of the inner guard 8 inches larger than the smoke pipe; and for all furnaces or where similar large hot fires are used, the diameter of the outside guard shall be not less than 18 inches and the diameter of the inner one, 12 inches larger in diameter than pipe. The smoke pipe thimbles shall extend from the under side of the ceiling or roof beams to at least 9 inches above the roof, and they shall have openings for ventilation at the top of the guards above the roof.

¶Where a smoke pipe of a boiler passes through a wooden roof, the same shall be guarded by a ventilated thimble, as before specified, 36 inches larger than the diameter of the smoke pipe of the boiler.

SEC. 124. Where smoke pipes pass through a wood or plastered partition, or furred wall, or floor, they shall be surrounded either by a body of hard, incombustible material, measuring at least 4 inches all around such smoke

pipe, or they shall be surrounded by a double safety thimble of sheet metal at least 1 inch apart, and the entire thimble so constructed that there will be a circulation of air between the two rings forming the same.

¶No smoke pipe shall project through an external wall unless connected with a chimney or metal stack carried above the roof.

SEC. 125. No stove or smoke pipe or any pipe conducting the products of combustion from any range, oven, or heater shall be concealed in any wood partition or be placed nearer than 9 inches to an unprotected lath and plaster or board partition, ceiling, or any woodwork.

SEC. 126. Smoke pipes of greater diameter than 12 inches and less area than 6 square feet, must be at least 20 inches from any woodwork, unless the same is properly protected by a shield, in which case the distance shall not be less than 12 inches.

¶Smoke pipes of larger area than 6 square feet shall be kept at least 3 feet distant from any woodwork, unless the same is properly protected by a shield, in which case the distance shall not be less than 18 inches.

SEC. 127. The metal shields prescribed in the previous section shall be at least twice the diameter of the pipe in width and shall have a ventilated air space of at least 1 inch between shield and woodwork.

SEC. 128. Where pipes are used for the distribution of hot air from hot-air furnaces in buildings, such pipes must be made of metal, and double; the space between the two metal pipes shall be at least ⅛ inch; such pipes shall be made with air-tight joints and be securely fastened to the partitions through which they pass; or, in lieu thereof, the pipes may be covered with asbestos paper, weighing not less than 14 pounds per 100 square feet; thoroughly pasted to pipes and also wired every 2 feet with wire or bands; and the studs and the other woodwork within 1 inch of the pipe shall be lined with bright tin, and the pipes shall be covered with metal lathing.

SEC. 129. The openings in floors for hot-air registers shall be surrounded with borders of incombustible material, not less than 2 inches wide, and securely set in place. The register boxes shall be double, the distance between the two thicknesses of tin being at least 1 inch, or they can be single if covered with asbestos paper, and the woodwork lined with tin in a manner similar to that specified in the preceding paragraph for the pipes. Such floor registers cannot connect directly down a pipe to the furnace; there must be an offset to catch dust and dirt and the register must be removable and the chamber kept clean.

CHAPTER XII

CHIMNEYS, FLUES, AND FIREPLACES

SEC. 130. The foundations of chimneys, flues, and stacks, whether inside or outside of buildings, or whether connected with the same or isolated, shall be designed and built in conformity with the provisions relating to foundations of buildings.

¶When the breast of a chimney or fireplace projects more than 4 inches it shall be started and built on the same line from the foundation.

SEC. 131. All chimneys shall be built of brick, stone, or other fireproof material. The exterior walls of chimneys shall be at least 4 inches thick and constructed with a suitable flue lining of terra cotta, or 8 inch walls without lining may be used.

SEC. 132. No chimney shall be corbeled from a wall more than 4 inches or be hung from a wall less than 12 inches thick unless it projects equally on each side of the wall; nor shall a chimney rest upon any wooden floor or beam.

SEC. 133. The walls of all chimneys shall rest upon footings at or below the level of the ground, or upon a continuous support of masonry or metal extending to footing as above stated; provided, however, that upon written permission of the Building Department chimneys may be built upon a footing or flooring of masonry or concrete supported by iron beams which have secure bearings on masonry, iron, or steel at both ends.

¶Where chimneys are supported by piers, the piers shall start from the foundation.

¶When a chimney is to be cut off below, in whole or in part, it shall be wholly supported by stone, brick, iron, or steel.

SEC. 134. All existing chimneys that the Department deems dangerous in any manner whatever, shall be repaired and made safe or taken down.

SEC. 135. No smoke flue shall be less than 8 inches by 8 inches.

¶All smoke flues shall be proportioned to the volume of gases to pass through the same.

SEC. 136. Not more than two stoves or two furnaces shall be connected with an 8-inch by 8-inch flue, nor more than four stoves or three furnaces with an 8-inch by 12-inch flue, and one flue only may serve more than one story if properly offset to prevent back-drafts.

SEC. 137. Where smoke pipes enter flues, the brickwork must be corbeled out to the face of the studs; the part thus corbeled out shall not be less than 16 inches by 16 inches, but in no case shall such corbeling exceed the thickness of the wall.

SEC. 138. Terra-cotta crocks shall be inserted for receiving all smoke pipes.

SEC. 139. Tops of chimneys shall extend at least 3 feet above flat roofs, and as high as the main ridge of pitched roofs, except that chimneys at or near the ridge shall extend at least 2 feet above the ridge.

SEC. 140. All fireplaces and chimneys in stone or brick walls in any building hereafter erected, except as herein otherwise provided, and any chimney or flue hereafter altered or repaired without reference to the purpose for which they may be used, shall have the joints struck smooth on the inside, except when lined on the inside with a well-burnt clay or terra cotta pipe.

SEC. 141. All fireplaces shall be at least 24 inches wide, and the hearth shall extend at least 12 inches beyond the opening on each side, and at least 18 inches in front.

SEC. 142. The firebacks of all fireplaces hereafter erected shall not be less than 8 inches in thickness of solid brickwork, nor less than 12 inches if of stone.

SEC. 143. When a grate is set in a fireplace a lining of firebrick, at least 2 inches in thickness, shall be added to the fireback, unless soap stone, tile, or cast iron is used.

SEC. 144. The walls of all high-pressure boiler flues shall not be less than 12 inches thick and the inside 4 inches of such walls shall be firebrick laid in fire mortar, for a distance of 25 feet from the source of heat.

SEC. 145. All smoke flues of smelting furnaces or of steam boilers, or other apparatus which heat the flues to a very high temperature, shall be built with double walls of suitable thickness and with an air space between the walls; the inside 4 inches of the flues shall be of firebrick laid in fire mortar, for a distance of not less than 25 feet from the source of heat.

SEC. 146. For any now-existing brick building where it becomes necessary to provide a smoke flue of larger size than any flue within the building, such flue may be placed on the outside of the building, and be made round

in shape and of sheet metal not less than ⅛ of an inch in thickness, properly riveted together at all joints and carried up to a height not less than 10 feet above the roof, and be properly braced at intervals for its entire length with flat iron bands secured with expansion bolts to the wall, leaving a free air space of not less than 4 inches between the outside of the metal flue and the brick wall of the building, and have a clean-out door at the bottom. This metal flue shall rest on a suitable cast iron base at the bottom, supported on a suitable foundation of masonry.

SEC. 147. Iron cupola chimneys of foundries shall extend at least 10 feet above the highest point of any roof within a radius of 50 feet of such cupola, and be covered on top with a heavy wire netting and capped with a suitable spark arrester.

¶No woodwork shall be placed within 2 feet of the cupola.

SEC. 148. All fireplaces and chimney breasts, whether intended for ordinary fireplace uses or not, shall have trimmer arches to support hearths, and no woodwork shall be used under such arches.

¶The said arches shall be at least 18 inches in width, measured from the face of the chimney breast, and they shall be constructed of brick, stone, burnt clay, or concrete.

¶The length of a trimmer arch shall not be less than the width of the chimney breast.

¶Wood centers under trimmer arches shall be removed before plastering the ceiling underneath.

SEC. 149. If a heater is placed in a fireplace, then the hearth shall be 6 inches wider than the full width of the heater.

¶All fireplaces in which heaters are placed shall have incombustible mantels.

SEC. 150. No wood mantel or other woodwork shall be exposed back of a summer piece; the iron work of the summer piece shall be placed against the brick or stonework of the fireplace.

SEC. 151. No fireplace shall be closed with a wood fireboard.

CHAPTER XIII

FRAME BUILDINGS AND BRICK-AND-FRAME BUILDINGS

SEC. 152. A frame building shall be taken to mean a building or structure of which the exterior walls shall be constructed of wood. Buildings sheathed with board and partially or entirely veneered on the outside with 4 inches of brickwork or other masonry shall be deemed frame buildings. Wood frames covered with metal shall be deemed frame buildings.

SEC. 153. Separate frame buildings other than tenement houses shall be located or built not less than 2 feet from the line of the lot upon which the same is located, when such building is one story in height, and at least 3 feet from said lot line for buildings two stories in height, and at least 4 feet from said lot line for buildings three stories in height.

SEC. 154. No frame building shall be hereafter erected or altered over three stories in height or to be occupied by more than six families. But nothing herein shall be taken to prevent the construction of blocks of frame buildings separated by fire walls as specified in this Code.

SEC. 155. In all frame dwellings hereafter erected, that are three stories in height, the outside or inclosing studs shall be not less than 2 inches by 6 inches, or its equivalent in strength; and where the height of outside walls is not more than 27 feet, 4 inches wide studding may be used, provided a 4-inch by 6-inch girt is introduced at the level of the first story ceiling.

SEC. 156. In all frame buildings that exceed 24 feet in depth, there shall be a middle post on each side 4 inches by 6 inches in one continuous length, and if buildings exceed 20 feet in width, there shall also be a post the same as above.

SEC. 157. All beams, girders, columns, trusses, and other structural members shall be proportioned of sufficient strength to sustain the load to be supported. In all cases suitable provisions shall be made to take up and properly distribute the stresses due to concentrated or eccentric loading, and also to prevent danger from horizontal or vertical deflection or the buckling or shear of members.

SEC. 158. The spaces between the studs on the top of first floor joists of outside and inside walls of all frame buildings shall be closed with 2-inch fire stops shutting off all spaces. On all the other floors of frame buildings constructed with a board girt, the spaces on the under side and also on top of joists, shall be filled with a fire stop not less than 2 inches thick, securely fastened and properly fitted to fill voids between outside studding.

SEC. 159. All wood beams and other timbers in any wall of a building built of stone, brick, concrete, or iron, shall be separated from the beam or timber entering in the opposite side of the wall by at least 4 inches of solid mason work; such separation may be obtained by corbeling or by staggering the beams.

SEC. 160. No beams or other timbers shall be cut for pipes or tubes in any manner which shall impair the strength of the timbers; and in no case shall they be cut further from the bearings than twice the depth of the timber. When studs are cut more than one-third their depth, they shall be reinforced. All cutting shall be done by or under the direction of the carpenter. Joists shall be bored near the middle for pipes, when it is impossible to place them as above provided.

SEC. 161. Drawings of all trusses and special or unusual framing showing sizes of members, shall be submitted with plans and specifications to the Building Department and, when required by the Building Department, a strain sheet showing stresses in truss members shall be submitted.

SEC. 162. All interior studding shall be but one story in height, set on caps or soles, except where partitions are over girders; the studding shall be seated on the girders and have caps not less than 3 inches thick with 2-inch fire stops at each story. Exterior studding shall be two stories high, or alternating, breaking joint at second story.

SEC. 163. All wood trimmer and header beams shall be proportioned to carry with safety the loads they are intended to sustain.

SEC. 164. The ends of all tail beams shall be properly framed, or hung to, or thoroughly spiked into, the header beams. In calculation of stresses, the factors of safety shall be used as given under the head "Factors of Safety" in this Code.

¶The ends of all beams buried in masonry walls shall be beveled back not less than 3 inches.

SEC. 165. In all 8-inch division walls, joists shall not rest in the wall, but shall be supported upon approved joist hangers, unless the wall is corbeled so as to keep the ends of joists 4 inches apart.

¶Walls shall be anchored to the ends of joists every 5 or 6 feet by wrought-iron anchors not less than ¼ inch by 1½ inches, and not less than 16 inches long.

¶Walls running parallel to joists shall be anchored by similar anchors extending over two joists.

SEC. 166. Wall plates shall be anchored to walls every 5 or 6 feet.

SEC. 167. No timber or other woodwork shall be placed within 1 inch of the outside of the wall of any chimney or flue.

SEC. 168. The ends of girders buried in walls shall have an air space around them.

SEC. 169. All wood floor and wood roof beams shall be properly bridged with cross bridging, and the distance between bridging or between bridging and walls shall not exceed 8 feet. Once in the length of all joists there shall be placed boards the full depth of the joist to act as cut-offs—fire barriers to stop the flue-like drafts between joists in frame buildings.

SEC. 170. Wood posts will not be allowed in cellars of any buildings.

SEC. 171. Frame buildings shall not be calculated or constructed to carry less than the minimum floor and roof loads specified in this Code. And no frame building shall be carried higher than three stories or 40 feet above the lowest point of street grade.

SEC. 172. Sills in frame buildings shall not be less than 4 inches by 6 inches.

SEC. 173. Girders shall not be less than 6 inches by 8 inches and shall be of sufficient strength to carry the superimposed load.

SEC. 174. The use of wood cornices is prohibited in the fire districts. All bay windows and projecting cornices over store windows within the outer fire limits, shall be constructed of or covered with metal or other incombustible material. If bay windows are constructed with studs, they shall be filled in solid with brickwork or hollow tile.

SEC. 175. Temporary one-story frame buildings may be erretcd for the use of builders, within the limits of lots whereon buildings are in course of erection, or on adjoining vacant lots, upon permits issued by the Building Deparmlnt, and for a speeific time.

¶Temporary structures shall also include platforms, stands, election booths, tents, and all such shelters. Permits therefor shall be limited to three months, excepting that contractors' offices above described may remain until such office space can be arranged within the permanent building.

SEC. 176. Sheds of wood within the outer fire limits not over 15 feet high nor over 20 feet square, open on at least one side, with the sides and roof thereof covered with fireproof material, may also be built, but a fence shall not be used at the back or side thereof.

SEC. 177. Fences of wood shall not be allowed inside the inner fire limits, and outside of them shall not be erected over 10 feet high above the surface of the ground, and shall be properly supported and braced.

SEC. 178. Signs of wood over 2 feet high shall not be erected on any building, and no sign of wood shall be placed above the front wall or cornice or roof of any building.

SEC. 179. Sky signs or any device in the nature of an advertisement, announcement, or direction, constructed of sheet metal or wire fastened to wood frames supported upon or above or attached to any building, will be permitted, but if such sky signs shall exceed 2 feet in height they shall be constructed entirely of metal, including the uprights, supports, and braces for same, and shall not be more than 20 feet in height above the front wall or cornice or roof of the building or structure to which they are attached or by which they are supported.

SEC. 180. Before any wood or metal sign shall be placed in position upon, above, or attached to, the outside of any building, or any fence built, or bill or advertising boards put up, a permit shall first be obtained from the Building Department. Such signs shall be so constructed, placed, and supported as not to be or become dangerous.

MILL CONSTRUCTION

SEC. 181. That form of construction in which heavy posts and girders, with wide spacing, support floors and roof of heavy planking, constitutes the structural framing contained within outer walls and roof covering of incombustible material.

SEC. 182. In mill construction, no timber shall be less than 6 inches in either of its cross-dimensions. Floor and roof planking of more than 5 feet spans shall not be less than 2¾ inches in thickness.

SEC. 183. Wood posts shall have cast-iron caps and bases with pintle connections, or steel or iron box caps with projections for receiving the ends of girders made so that the girders shall be self-releasing.

SEC. 184. Mill construction shall be in strict accord with the requirements of the National Board of Underwriters. All the timbers shall be self-releasing from the posts and walls. There shall be fireproof stairs in fire-

proof walls at or outside the outer walls. The openings in floors shall be fire guarded. The floors shall be drained and scuppered to the outside. The roof covering shall be fire-resisting and mill constructed buildings shall not be permitted in the inner fire limits.

¶Mill construction, within brick or stone or concrete walls, shall be permitted to four stories or 55 feet above the lowest point of street grade.

¶So-called "Semi-Fireproof" construction of wood joists and steel beams in brick or concrete or stone walls, *i. e.*, any system in which wood enters as a structural element in any way whatsoever, may also be carried up to four stories or 55 feet above the lowest point of street grade.

CHAPTER XIV

FIREPROOF CONSTRUCTION

SEC. 185. Fireproof construction shall be required in:

(*a*) Every building hereafter erected or altered to be used for any purpose, over four stories in height, or four stories and basement, or over 55 feet in height.

(*b*) All public buildings and all other buildings hereafter erected or altered to be used as hotels, or lodging-houses, or apartments, or for any other purpose not herein especially enumerated, or buildings in which many people congregate or are employed, and which are over three stories in height, or three stories and basement, or 45 feet in height, or buildings containing an assembly hall, all schools, hospitals, asylums, department stores, shops, or factories over two stories and a basement. Except in all cases under heading "b" where the first floor is made of fireproof construction, one extra story in height is allowed. Provided, however, that all the hallways, stairways, and corridors in each and every building described in this heading "b" shall be made of fireproof construction.

(*c*) All theaters hereafter constructed, or buildings altered to be used for such, having a seating capacity of 600 or more.

(*d*) All buildings used for the storage of petroleum or other articles of a like nature which shall be subject to the approval of the Fire Marshal.

SEC. 186. A building shall be considered fireproof when constructed with walls of well burned brick or hollow tile; granite or stone; Portland cement concrete, solid or in blocks; iron or steel, in which wood beams or lintels shall not be placed and in which the floors and roofs shall be constructed with rolled steel or reinforced-concrete floor beams and girders, and in which all steel or damageable material is protected by a fire-resistant covering.

¶The spaces between the beams and girders shall be filled with arches or slabs of fire-resisting materials or continuous reinforced concrete or terra cotta slabs without beams, or girders may be used. But any novel or other system of construction with which the Department is not familiar may first be subjected to such tests as are provided in Section 198 before being approved by it and the construction permitted to proceed.

SEC. 187. Between the floor and roof beams shall be placed brick arches springing from the lower flanges of the steel beams, or the spaces between the beams may be filled with hollow tile arches segmental or flat, of hard burnt clay or porous terra cotta, or arches of Portland cement concrete, reinforced with metal, or other fireproof composition may be used, provided that in each and all cases the strength and method of construction shall conform to the requirements of the Building Department and the building generally shall conform to the specifications of Sections 188 to 193 inclusive.

SEC. 188. The stairs and staircase landings shall be constructed of brick, hollow tile, stone, marble, glass, slate, Portland cement concrete, iron or steel, or a combination of these materials.

SEC. 189. No woodwork or other inflammable materials shall be used in any of the partitions, furrings, or ceilings in any such fireproof buildings, excepting, however, that when the height of the building does not exceed six stories nor more than 80 feet, the doors and windows and their frames and trims, the casings, the interior finish when filled solidly at the back with fireproof material, and the spaces under the floor boards and between the sleepers shall be solidly filled with concrete or incombustible materials extending up to the under side of the floor boards.

SEC. 190. When the height of a fireproof building exceeds six stories, or more than 80 feet, the floor surfaces shall be of stone, cement, hollow tiling, or similar incombustible material. All outside window frames and sash shall be of metal and where the building may be endangered by adjacent structures or from across narrow streets (less than 30 feet) and alleys there shall be wired glass in the metal sash or other equivalent window protection.

¶The inside window frames and sash, doors, trim, and other interior finish may be of metal or of wood covered with metal, or of such other incombustible material that may be approved by the Building Department, and these sash glazed with wire glass, or have other suitable protection to act as fire cut-offs, dividing the floor area into units of reasonable size and never in excess of what is provided in Section 397.

SEC. 191. All hall partitions or permanent partitions between rooms in fireproof buildings shall be built of fireproof material and shall not be started on wood sills nor on wood floor boards, but be built upon the fireproof construction of the floor and extend to the fireproof arches above.

¶The tops of all door and window openings in such partitions shall be at least 12 inches below the ceiling line.

SEC. 192. In all fireproof partitions, other than when made of solid brickwork, the openings for doors and windows in the same shall be framed on both sides with iron studs or uprights secured at top and bottom to the floor construction, and with like iron horizontals between the said uprights for the window and door heads, or such other incombustible construction as may be approved by the Building Department.

SEC. 193. In all fireproof buildings, other than stores, warehouses, and factories, if exceeding three stories or 45 feet in height, the stair halls and the elevators shall be enclosed on each story with fireproof material, forming an enclosure, the floor area of which shall not be less than 3 times the united area of the floor openings for the elevators and the stairs. Or the stair and the elevator shafts may be enclosed in wire glass in metal frames, or other such equivalent protection, and right on the line of the floor opening if desired. But in every case at each story there shall be fireproof, solid or transparent, self-closing doors to each such stair and elevator, or stair or elevator hall.

SEC. 194. Fireproof floors between the steel floor beams may be in the form of brick arches springing from the lower flanges of the steel beams.

¶Said brick arches shall be designed with a rise to safely carry the imposed load, but never less than 1¼ inches for each foot of span between the beams, and they shall have a thickness of not less than 4 inches for spans of 6 feet or less, and 8 inches for spans over 6 feet or such additional thickness as may be required by the Building Department.

¶Said brick arches shall be composed of good hard brick or hollow brick of ordinary dimensions laid to a line on the centers, properly and solidly bonded, each longitudinal line of brick breaking joints with the adjoin-

ing lines in the same ring and with the ring under it when more than a 4-inch arch is used. The said arches shall spring from protecting skewbacks of burnt clay resting on and covering the lower flanges of the beams, so as to afford a minimum protection of 2 inches of solid burnt-clay material underneath the flanges; or otherwise entirely incasing the said flanges as provided for in this section. The brick shall be well wet and the joints filled in solid with strong Portland cement mortar. The arches shall be grouted and properly keyed.

SEC. 195. Or the spaces between the beams may be filled with hollow tile flat or segmental arches of hard burned clay, semi-porous or porous terra cotta blocks of uniform density and hardness of burn. The shells and webs of hollow tile arch blocks shall not be less than $\frac{5}{8}$ of an inch in thickness, if of dense or semi-porous terra cotta, or 1 inch if of porous terra cotta.

¶Skewbacks shall be used in all forms of brick or hollow tile arches and be of such form and section to properly receive the thrust of the arches. The shells and webs of side-construction skewbacks shall not be less than $\frac{3}{4}$ of an inch in thickness, if of dense or semi-porous terra cotta, or $\frac{7}{8}$ inch if of porous terra-cotta, except that the portion extending under the lower flange of the beams shall not be less than $1\frac{1}{2}$ inches of solid material.

¶The said arches shall be of a depth and sectional area to carry the load to be imposed thereon, without straining the material beyond its safe working load, but the thickness of the shells and webs shall in no case be less than herein required and the depth of hollow tile flat arches shall not be less than $1\frac{1}{2}$ inches per foot of span, not including any portion of the depth of the tile projecting below the under side of the beams.

¶The joints shall be solidly filled with strong Portland cement mortar of 1 part Portland cement, 3 parts sand, and not more than $\frac{1}{10}$ part lime putty, and the arch so constructed that the key parts shall fall as near the central portions as possible.

SEC. 196. Or the space between the beams may be filled with arches of Portland cement concrete, segmental in form, and which shall have a rise of not less than $1\frac{1}{4}$ inches for each foot of span between the beams.

¶The concrete shall be not less than 4 inches in thickness at the crown of the arch and shall be mixed in the proportions required by this Code. These segmental arches shall in all cases be reinforced with steel rods or bars, reticulated or meshed steel, or similar metal weighing not less than 1 pound per square foot. Such reinforcing metal shall be so imbedded that the metal is covered by not less than $1\frac{1}{2}$ inches of concrete.

¶Or the spaces between the beams may be filled with flat arches or slabs of cinder-concrete which shall be used only after a satisfactory test has been approved by the Department. These slabs or arches shall consist of cinder-concrete composed of one part of Portland cement, two parts of sand and five parts of good, clean, anthracite, steam boiler cinders.

¶The depth of the slab shall be sufficient to sustain the load to be imposed thereon, with a factor of safety of six, but the depth shall not be less than three-quarters inch for each foot of span between the beams, and in no case less than 4 inches.

¶The reinforcement shall consist of steel rods or bars of meshed steel metal fabric proportioned to take up all tensional strains but in no case to be less than one pound per square foot of floor area.

¶The concrete fireproofing protection on all beams, girders, and other structural members shall be reinforced with suitable metal clips or fabric.

SEC. 197. Concrete shall not be mixed or deposited at a freezing temperature unless special precautions are taken to avoid the use of materials containing frost, or covered with ice crystals, and to provide means to prevent the concrete from freezing after being placed in position until it is thoroughly hardened. Any concrete damaged by freezing or otherwise shall be removed.

SEC. 198. Or between the said beams may be placed solid or hollow burnt clay, brick, or concrete arches in flat or curved shapes, concrete or fire proof composition slabs, and any of said materials may be used plain or in combination with wire cloth, expanded metal, wire strands, or wrought iron or steel bars; the said metal, if used, to be in all cases so imbedded in the fireproof composition or combination that the metal shall be covered by not less than 1½ inches of fireproof material; but in any unusual construction and as a precedent condition to the same being used, tests shall be made by the United States Bureau of Standards, or by the National Underwriters' Laboratory, or by some state or impartial private laboratory, approved by either of the aforesaid authorities, which is habitually making and is equipped to make tests of building materials. Such tests shall be paid for by the manufacturer, owner, or patentee thereof under the direction and to the satisfaction of the Building Department, and evidence of the same shall be kept on file in the office of the said Department showing the nature and result of the test. Or the Department may accept the evidence of similar tests properly though previously made for other cities or parties.

¶All such tests shall be load, fire, and water tests.

¶Further, the Department may insist upon other reasonable tests by load, fire, and water of any section of such novel construction, or of the regular, standard constructions, if in the Department's estimation the work does not appear to come up to the spirit of the requirement of these regulations.

¶Any system failing to meet the requirements of these tests that shall simulate the conditions to which such construction may be exposed, shall be prohibited from use in any building hereafter erected.

SEC. 199. No filling of any kind which may be injured by frost shall be placed between said floor beams during freezing weather and if the filling is placed during any winter month, it shall be temporarily covered with suitable material for protection from being frozen. Nor shall any other concrete or masonry work or any work than can be seriously affected by frost, any work in the actual structural, weight, pressure sustaining, or fire protecting portions of a building, be done in freezing weather unless such provision for its protection be made as will meet the approval of the Building Department.

SEC. 200. On the top of any arch, lintel, or other device which does not extend to the plane of the under side of the floor finish, cinder concrete or other non-combustible material shall be placed to solidly fill up the space to a level with the top of said floor beams, and shall be carried to the under side of the wood floor boards in case such be used.

¶Cinder concrete for filling shall be made with not less than 1 part of Portland cement to 10 parts of clean cinders, machine mixed. Before such filling, the exposed tops of all beams or other steel work, the metal pipes and wire conduits and any other metal work entering into the construction of or resting upon such floor construction must be well grouted or covered with a coating of tarred-paper, or felt, or Portland cement mortar—something to insure that the cinder concrete will not come in immediate contact with such metal work. The cinder or other concrete filling must entirely embed all the tops of the steel beams and girders and be carried to at least 2 inches above them.

SEC. 201. Under no consideration shall forms be removed until the concrete has hardened sufficiently to permit their removal with perfect safety.

SEC. 202. In laying the floors in masonry buildings, proper provision shall be made to allow for the swelling of floors to prevent throwing out or buckling of walls.

SEC. 203. All fireproof floor systems shall be of sufficient strength to safely carry the load to be imposed thereon without straining the material in any case beyond its safe working load.

SEC. 204. Openings through fireproof floors for pipes, conduits, and similar purposes shall be shown on plans filed with the Building Department.

¶After the floors are constructed, no opening greater than 8 inches square shall be cut through said floors, unless properly boxed or framed around with iron, and such openings shall be filled in with fireproof material after the pipes or conduits are in place.

SEC. 205. All cast-iron, wrought-iron, or rolled-steel columns, including the lugs and brackets on same, used for vertical supports in the interior of any fireproof building, or used to support any fireproof floor, shall be entirely protected with not less than 4 inches of hard burnt brickwork, terra cotta, hollow tile concrete, or other fireproof material, without any air space next to the metal (all voids and spaces to be well grouted with cement), securely applied; but no plaster of paris or lime mortar shall be used for this purpose nor shall any plaster, whether or not on metal lathing, be considered a part of the covering required.

¶Columns of solid terra cotta or of hollow terra cotta in which the sectional area of the open holes in each block shall not exceed 20 per cent of the gross sectional area of such a block, may be used for structural purposes provided the height of such column shall not exceed 12 times the least dimension. The allowable stress shall not exceed 500 pounds per square inch. Such columns shall be of hard burned terra cotta tile of uniform quality, without cracks, with true beds and having ultimate compressive strength of not less than 4,000 pounds per square inch of net area of cross-section of samples tested, and the mortar used in setting these tile columns shall be one part Portland cement and three parts clean, sharp sand thoroughly mixed.

SEC. 206. No single block or unit of insulating material used for column covering shall have a greater vertical dimension than 12 inches when placed in position, nor shall the shell and webs of hollow tile or terra-cotta blocks be less than ¾ inch in thickness, and these blocks shall be laid up with Portland cement mortar and the said blocks shall be suitably tied or anchored together, bonded with metal mesh in the joints or wound about with wire or band metal.

¶The extreme outer edges of lugs, brackets, and similar supporting metal may project to within 1 inch of the surface of the fireproofing.

¶The fireproof coverings shall start upon the fireproof floors and continuously extend to within 1 inch of the fireproof ceilings or under side of girders above and be entirely independent of any ornamental base or capital.

¶The 1-inch space left at the top shall be filled with asbestic or other plastic, non-melting and non-inflammable elastic cement, to permit this column covering to expand in fire and to nullify the tendency to "throw out" from the column.

SEC. 207. No pipes, wires, or conduits of any kind shall be incased in the fireproofing surrounding any column, girder, or beam of steel or iron, but shall be placed outside of such fireproofing, although such pipes, wires, and conduits may be within a casing or fireproof covering that will enclose them and the column with its complete fireproofing in one large column, for ornamental purposes.

SEC. 208. Where the fireproof protection of columns is exposed to damage from the trucking or handling of merchandise, such fireproof protection shall be jacketed on the outside, for a height not less than 4 feet from the floor, with sheet metal, or with vertical strips of oak; and if the oak be used for such purpose the vertical strips shall be sufficiently separated from each other always to show that the woodwork of the guard has been placed entirely on the outside of the fireproof material which incases the metal column.

SEC. 209. The exposed sides of wrought-iron or rolled-steel girders supporting walls, iron, or steel floor beams, or supporting floor arches or floors, shall be entirely incased with hard burnt clay, porous terra cotta, hollow tile, concrete, or other fireproof materials not less than 4 inches in thickness, and the bottom and top plates and flanges of such girders shall have not less than 2 inches in thickness of such insulating material.

SEC. 210. The bottom and top plates and flanges of all wrought-iron and rolled-steel floor and roof beams and all exposed portions of such beams below the abutments of floor arches or filling between the floor beams shall be entirely incased with hard burnt clay, porous terra cotta, hollow tile, concrete, or other fireproof material, such incasing material to be not less than 1½ inches thick.

SEC. 211. All incasing material shall be securely attached to the girders and beams.

SEC. 212. The shells and webs of hollow tile blocks used for girders and column coverings shall be of porous terra cotta, hollow tile not less than ¾ inch in thickness, and shall be laid up with strong Portland cement mortar, and the said blocks shall be suitably tied or anchored together.

SEC. 213. Where columns are used to support iron or steel girders carrying enclosure walls, the said columns shall be of cast iron, or rolled steel, and

their exposed surfaces shall be constructed to resist fire by having a casing of brickwork not less than 8 inches in thickness on the outside surfaces and all bonded into the brickwork of the enclosure walls.

¶Between the said inclosing brickwork and the columns, there shall be a space of not less than 2 inches, which space (as all other spaces about columns) shall be filled solidly with liquid cement grout as the courses of brickwork are laid.

SEC. 214. The exposed sides of the steel girders shall be similarly covered with brickwork not less than 4 inches in thickness on the outer surface and tied and bonded, but the extreme outer edge of the flanges of beams or plates or angles connected to the beams may project to within 2 inches of the outside surface of the brick casing.

SEC. 215. The inside surfaces of girders may be similarly covered with brickwork, or if projecting inside of the wall, they shall be protected by terra cotta, hollow tile, concrete, or other fireproof material not less than 4 inches in thickness, and with cement grouting next to the metal wherever it is possible to run it.

SEC. 216. Girders for the support of the enclosure walls shall be placed at the floor line of each story.

SEC. 217. The skeleton steel frame of a building shall be independent from that of an adjoining building, and the frame of one building shall not be bolted or riveted in any manner to the frame of any other building.

SEC. 218. No steel-framed or other fireproof building shall be carried higher than twice the width of the street upon which it faces. And in no case, whatever the location, upon however steep a hill, shall any building be over 200 feet from the lowest point of curb level for every 50 feet of its frontage, to the top of the flat roof or to within 6 feet of the top of a pitched gable-roof. Provided, however, that spires, towers, domes, or such vertical projections of limited area—never more than one-half the area—of the building above which they rise, must be built of absolutely fireproof construction and of such height and size as may be approved by the Building Department. And such towers, spires, etc., may only be on the party lines of such lots with the approval of the adjoining owner and the Building Department.

¶Or, such fireproof buildings may be carried up to the full limit of 200 feet provided that they be stepped-back, or receded, at the level of twice the width of the street, and the new line of frontage shall be back to that point, from

the center of the street, that would be established if the street were of such a width as would permit a 200-foot building 50 feet from the center of the street. Provided also that if such buildings back upon an alley they shall only be as high upon that alley as if they extended only to twice the width of the fronting street in height, the extra height to the 200-foot limit shall be carried up 12 feet back from the alley line.

CHAPTER XV

REINFORCED CONCRETE CONSTRUCTION

SEC. 219. *Definition, Plans.*

¶The term "reinforced concrete" means any combination of metal imbedded in concrete to form a structure so that the two materials assist each other to sustain all the stresses imposed. Before a permit to erect any reinforced concrete structure is issued, complete plans and specifications shall be filed with the Department, showing all details of the construction, including detail of working joints, the size and position of all reinforced rods, stirrups or other forms of metal, and giving the composition and proportion of the concrete; provided, however, that permission to erect any reinforced concrete structure does not in any manner approve the construction until after tests have been made of the actual construction to the satisfaction of the Department.

SEC. 220. *Ratio of Moduli of Elasticity, Adhesion, Bond.*

(*a*) The calculations for the strength of reinforced concrete shall be based on the assumed ultimate compressive strength per square inch designated by the letter "U" given in the table below for the mixture to be used.

(*b*) The ratio designated by the letter "R" of the modulus of elasticity of steel to that of the different grades of concrete shall be taken in accordance with Table II:

TABLE II

Strength of Concrete Mixtures

MIXTURE	U	R
1 cement, 1 sand, 2 broken stone, gravel or slag	2900	10
1 cement, 1½ sand, 3 broken stone, gravel or slag	2400	12
1 cement, 2 sand, 4 broken stone, gravel or slag	2000	15
1 cement, 2½ sand, 5 broken stone, gravel or slag	1750	18
1 cement, 3 sand, 7 broken stone, gravel or slag	1500	20

SEC. 221. *Unit Stresses for Steel and Concrete.*

(*a*) The stresses in the concrete and the steel shall not exceed the following limits:

(*b*) Tensile stress in steel shall not exceed one-third of its elastic limits and shall not exceed 18,000 pounds per square inch.

(*c*) Shearing stress in steel shall not exceed 12,000 pounds per square inch.

(*d*) The compressive stress in steel shall not exceed the product of the compressive stress in the concrete multiplied by the elastic modulus of the steel and divided by the elastic modulus of the concrete.

(*e*) Direct compression in concrete shall be one-fifth of its ultimate strength. Bending in extreme fiber of concrete shall be thirty-five one-hundredths of the ultimate strength.

(*f*) Tension in concrete on diagonal plane shall be one-fiftieth of the ultimate compressive strength.

(*g*) For a concrete composed of one part of cement, two parts of sand, and four parts of broken stone, the allowable unit stress for adhesion per square inch of surface of imbedment shall not exceed the following:

	Pounds per Sq. Inch
On plain round or square bars of structural steel.....	70
On plain round or square bars of high carbon steel	50
On plain flat bars, in which the ratio of the sides is not more than 2 to 1.....	50
On twisted bars when the twisting is not less than one complete twist in eight diameters.....	100

(*h*) For specially formed bars, the allowable unit stress for bond shall not exceed one-fourth of the ultimate bond strength of such bars without appreciable slip, which shall be determined by tests made by the person, firm, or corporation to the satisfaction of the Department, but provided that in no case shall such allowable unit stress exceed 100 pounds per square inch of the specially formed bars.

SEC. 222. *Design for Slabs, Beams, and Girders.*

¶Reinforced concrete slabs, beams, and girders shall be designed in accordance with the following assumptions and requirements:

(*a*) The common theory of flexure shall be applied to beams and members resisting bending.

(*b*) The adhesion between the concrete and the steel shall be sufficient to make the two materials act together.

(*c*) The steel to take all the direct tensile stresses.

(*d*) The stress strain curve of concrete in compression is a straight line.

(*e*) The ratio of the moduli of elasticity of concrete to steel shall be as before specified.

SEC. 223. *Moments of External Forces.*

(*a*) Beams, girders, floor or roof slabs, and joists shall be calculated as supported or with fixed ends, or with partly fixed ends, in accordance with the actual end conditions, the number of spans, and the design.

(*b*) When calculated for ends partly fixed for intermediate spans with an equally distributed load where the adjacent spans are of approximately equal lengths:

¶Bending moment at center of spans shall not be less than that expressed in the formula $\frac{WL^2}{12}$ for intermediate spans and $\frac{WL^2}{10}$ for end spans.

(*c*) The moment over supports shall not be less than the formula $\frac{WL^2}{18}$ and the sum of the moments over one support and at the center of span shall be taken not less than the formula $\frac{WL^2}{6}$.

¶In the formula hereinabove given W is the load per linear foot and L is the length of span in feet.

(*d*) In case of concentrated or special loads the calculations shall be based on the critical condition of loading.

(*e*) For fully supported slabs, the span shall be taken as the free opening plus the depth; for continuous slabs, the span shall be the distance between centers of supports.

(*f*) Where the vertical shear measured on the section of a beam or girder between the centers of action of the horizontal stresses, exceeds one-fifth of the ultimate direct compressive stress per square inch, web reinforcement shall be supplied sufficient to carry the excess. The web reinforcement shall extend from top to bottom of beam and loop or connect to the horizontal reinforcement. The horizontal reinforcement carrying the direct stresses shall not be considered as web reinforcement.

(*g*) In no case, however, shall the vertical shear, measured as stated above, exceed one-fifteenth of the ultimate compression strength of the concrete.

(*h*) For T-beams the width of the stem only shall be used in calculating the above shear.

(*i*) When steel is used in the compression side of beams and girders, the rods shall be tied in accordance with requirements of vertical reinforced columns with stirrups connecting with the tension rods of the beams or girders.

(*j*) All reinforcing steel shall be accurately located in the forms and secured against displacement and properly inspected before any surrounding concrete be put in place. It shall be afterwards completely inclosed by the concrete, and such steel shall nowhere be nearer the surface of the concrete than 1½ inch for columns, 1½ inch for beams and girders, and ½ inch, but not less than the diameter of the bar, for slabs.

(*k*) The longitudinal steel in beams and girders shall be so disposed that there shall be a thickness of concrete between the separate pieces of steel of not less than one and one-half times the maximum sectional dimension of the steel.

(*l*) For square slabs with two-way reinforcements, the bending moment at the center of the slab shall not be less than that expressed in the formula

$\frac{WL^2}{24}$ for intermediate spans, and $\frac{WL^2}{20}$ for end spans.

(*m*) The moment over supports shall not be less than the formula $\frac{WL^2}{36}$ and the sum of the moments over one support and at the center of the span shall be taken not less than the formula $\frac{WL^2}{12}$.

¶In the above formula W is the load per lineal foot and L the length of the span.

(*n*) For squares or rectangular slabs the distribution of the loads in the two directions, shall be inversely as the cubes of the two dimensions.

(*o*) Exposed metal of any kind will not be considered a factor in the strength of any part of any concrete structure, and the plaster finish applied over the metal shall not be deemed sufficient protection unless applied of sufficient thickness and so secured as to meet the approval of the Department.

SEC. 224. *Limiting Width of Flange in T-Beams.*

(*a*) In the calculation of ribs a portion of the floor slab may be assumed as acting in flexure in combination with the rib. The width of the slab so acting in flexure is to be governed by the shearing resistance between rib and slab, but limited to a width equal to one-third of the span length of the ribs between supports and also limited to a width of three-quarters of the distance from center to center between ribs.

(*b*) No part of the slab shall be considered as a portion of the rib unless the slab and rib are cast at the same time.

(*c*) Where reinforced concrete girders support reinforced concrete beams, the portion of floor slab acting as flange to the girder must be reinforced with

rods near the top at right angles to the girder, to enable it to transmit local loads directly to the girder and not through the beams.

SEC. 225. *Shrinkage and Thermal Stresses.*

¶Shrinkage and thermal stresses shall be provided for by introduction of steel.

SEC. 226. *Reinforced Concrete Columns—Limit of Length—Per Cent of Reinforcement—Bending Moment on Columns—Tying Vertical Rods.*

(*a*) Reinforced concrete may be used for columns in which the concrete shall not be leaner than a 1:2:4 mixture and in which the ratio of length to least side or diameter does not exceed 12 but in no case shall the cross-section of the columns be less than 64 square inches. Longitudinal reinforcing rods must be tied together to effectively resist outward flexure at intervals not more than twelve times least diameter of rod and not more than 18 inches. When compression rods are not required, reinforcing rods shall be used, equivalent to not less than one-half of one per cent (.005) of the cross-sectional area of the column; provided, however, that the total sectional area of the reinforcing steel shall not be less than 1 square inch and that no rod or bar be of smaller diameter or least dimension than ½ inch. The area of reinforcing compression rods shall be limited to three per cent of cross-sectional area of the column. Vertical reinforcing rods shall extend upward or downward into the column, above or below, lapping the reinforcement above or below enough to develop the stress in rod by the allowable unit for adhesion. When beams or girders are made monolithic with or rigidly attached to reinforced concrete columns, the latter shall be designed to resist a bending moment equal to the greatest possible unbalanced moment in the beams or girders at the columns, in addition to the direct loads for which the columns are designed.

(*b*) When the reinforcement consists of vertical bars and spiral hooping, the concrete may be stressed to one-fourth of its ultimate strength, provided that the amount of vertical reinforcement be not less than the amount of the spiral reinforcement, nor greater than eight per cent of the area within the hooping; that the percentage of spiral hooping be not less than one-half of one per cent, nor greater than one and one-half per cent; that the pitch of the spiral hooping be uniform and not greater than one-tenth of the diameter of the column, nor greater than 3 inches; that the spiral be secured to the verticals, at every intersection, in such a manner as to insure the maintaining of its form and position, that the verticals be spaced so that their distance apart, measured on the circumference, be not greater than 9 inches, or one-eighth the circumference of the column within the hooping. In such columns the action of the hooping may be

assumed to increase the resistance of the concrete equivalent to two and one-half times the amount of the spiral hooping figured as vertical reinforcement. No part of the concrete outside of the hooping shall be considered as a part of the effective column section.

SEC. 227. *Structural Steel Columns.*

¶When the vertical reinforcement consists of a structural steel column of box shape, with lattice or batten plates of such form as to permit its being filled with concrete, the concrete may be stressed to one-fourth of its ultimate strength, provided that no shape of less than one square inch section be used and that the spacing of the lacing or battens be not greater than the least width of the columns.

SEC. 228. *Curtain Walls in Skeleton Construction Buildings.*

¶Buildings having a complete skeleton construction, or a combination of both, may have exterior walls of reinforced concrete 8 inches thick, provided, however, that such walls shall support only their own weight and that such walls shall have steel reinforcement of not less than three-tenths of one per cent in each direction vertically and horizontally, the rods spaced not more than 12-inch centers and wired to each other at each intersection. All bars shall be lapped for a length sufficient to develop their full stress for the allowable unit stress for adhesion. Additional bars shall be set around openings, the verticals wired to the nearest horizontal bars, and the horizontal bars at top and bottom of openings shall be wired to the nearest vertical bars. The steel rods shall be combined with the concrete and placed where the combination will develop the greatest strength, and the rods shall be staggered or placed and secured so as to resist a pressure of thirty pounds per square foot, either from the exterior or from the interior on each and every square foot of each wall panel.

SEC. 229. *Bending and Elongation of Steel.*

¶The bending and elongation of steel used in reinforced concrete construction shall conform to the following requirements:

(*a*) Steel having a diameter of ¾-inch or less shall be capable of bending cold ninety degrees over a diameter equal to twice the thickness of the piece without fracture; steel over ¾-inch in diameter shall be capable of bending cold to ninety degrees over a diameter equal to three times the diameter of the piece.

(*b*) The material of reinforcement shall be such form that it will not elongate under working stress to exceed one fifteen-hundredth.

(*c*) Reinforcing steel used in reinforcing concrete construction shall not be painted but shall be free from all mill scale and loose rust.

SEC. 230. *Cement Tests.*

(*a*) Only Portland cement shall be used in reinforced concrete construction. All cement shall be tested in car load lots when delivered, or in quantities equal to the same. Cement failing to meet the requirements of accelerated test shall be rejected.

(*b*) Parts of neat cement must be allowed to harden twenty-four hours in moist air, and then be submitted to the accelerated test as follows: A pat is exposed in any convenient way in an atmosphere of steam, and above boiling water, in a loosely closed vessel for three hours, after which before the pat cools, it is placed in the boiling water for five additional hours. To pass this test satisfactorily, the pat shall remain firm and hard and show no signs of cracking, distortion, or disintegration.

(*c*) Portland cement when tested shall have a minimum tensile strength as follows: Neat cement after one day in moist air shall develop a tensile strength of at least 200 pounds per square inch; after one day in air and six days in water shall develop a tensile strength of at least 500 pounds per square inch, and after one day in air and twenty-seven days in water, shall develop a tensile strength of at least 600 pounds per square inch. Cement and sand tests composed of one part of cement and three parts of sand shall, after one day in air and six days in water, develop a tensile strength of at least 175 pounds per square inch; and after one day in air and twenty-seven days in water, shall develop a tensile strength of at least 240 pounds per square inch.

(*d*) A certificate that the cement used has been tested and has met the requirements of this section and that the tests have been made in accordance with the standard methods prescribed by the American Society for Testing Materials, on pages 149 to 164, both inclusive, of the Proceedings of the Eleventh Annual Meeting of the American Society for Testing Materials, adopted August 15, 1908, shall be furnished to the Department by the architect or engineer in charge.

SEC. 231. *Sand.*

¶The sand to be used for concrete shall be clean, hard, coarse sand, of the grade known as torpedo sand, and free from loam or dirt; not less than 45 per centum shall be returned on a screen of 400 mesh to the square inch.

SEC. 232. *Stone.*

¶The stone to be used in concrete shall be clean crushed hard stone or clean crushed blast furnace slag or gravel of a size to pass through a 1-inch square mesh. If limestone or slag is used, it shall be screened to remove all dust; if gravel is used it shall be thoroughly washed. Stone shall be

drenched immediately before using. If slag is used, it shall be of such character that when made into concrete the concrete will develop a crushing strength equal to that specified for stone or gravel concrete.

SEC. 233. *Mixing.*

¶All concrete shall be mixed in a mechanical mixer, except when limited quantities are required, or when the conditions of the work make hand mixing preferable; hand mixing to be done only when approved by the Department. In all mixing, the separate ingredients shall be measured and shall be thoroughly mixed and must be uniform in color, appearance, and consistency, before placing.

SEC. 234. *Placing Concrete.*

¶In filling in concrete around reinforcing steel, the concrete must be worked continuously with suitable tools, as it is put in place. Filling the forms completely and puddling afterwards will not be permitted. In placing the concrete, the work shall be so laid out that partly set concrete will not be subjected to shocks from men wheeling or handling material over it.

SEC. 235. *Concrete Placed in Freezing Weather.*

¶When concreting is carried on in freezing weather, the material must be heated, and such provisions made that the concrete can be put in place without freezing. The use of frozen, lumpy sand or stone depending on hot water used in mixing to thaw it out will not be permitted. All reinforced concrete shall be kept at a temperature above freezing for at least forty-eight hours after being put in place. All forms under concrete placed in freezing weather shall remain until all evidences of frost are absent from the concrete and the natural hardening of the concrete has proceeded to the point of safety.

SEC. 236. *Concrete Placed in Warm Weather.*

¶Concrete laid in warm weather shall be drenched with water twice daily, Sunday included, during the first week after being put in place.

SEC. 237. *Cement Finish.*

¶Cement finish added to the top of slabs, beams, or girders, shall not be calculated in the strength of a member unless laid integrally with the rough concrete. No greater unit stress shall be allowed on such cement finish than on the rough concrete.

SEC. 238. *Fireproof Concrete Construction.*

¶Reinforced concrete construction will be accepted for fireproof buildings

if designed as prescribed in this paragraph. The aggregate for such concrete shall be clean, broken stone or clean crushed blast furnace slag, or clean screened gravel, together with clean, coarse sand of the grade known as torpedo sand; stone, slag, or gravel shall be of a size to pass through a screen of ¾ inch mesh. The minimum thickness of concrete surrounding the reinforcing members of reinforced concrete beams and girders shall be 2 inches on the bottom, and 1½ inches on the sides of said beams and girders. The minimum thickness of concrete under slab rods shall be 1 inch; and all reinforcement in columns shall have a minimum protection of 2 inches of concrete except as hereinafter provided, if a supplementary metal fabric is placed in the concrete surrounding the reinforcing, simply for holding the concrete, the thickness of concrete under the reinforcing may be reduced by one-half inch, then such fabric shall not be considered as reinforcing metal.

SEC. 239. *Removal of Forms.*

¶In no case shall the props and shores used in reinforced concrete construction be removed from under floors and roofs in less than two weeks, except as is provided herein. Column forms shall not be removed in less than four days. The centering from bottom of slabs and sides of beams and girders may be removed after the concrete has set for one week, if the floor has obtained sufficient hardness to sustain the dead weight of the said floor. No load or weight shall be placed on any portion of the construction until the concrete has fully set and the centers have been removed.

SEC. 240. *Tests.*

¶The contractor for the reinforced concrete construction shall make load tests on any portion of the work within a reasonable time after erection, as may be required by the Department. Such tests must be made under the direction of the Department and must show that the construction will sustain a load twice the sum of the live and dead loads for which it was designed, without any sign of failure. The construction may be considered as part of the test load. Each test load shall cover two or more panels and shall remain in place at least twenty-four hours. The deflection under the full test load at the expiration of twenty-four hours shall not exceed one eight-hundredth of the span. These tests shall be considered as tests of workmanship only.

SEC. 241. *Fire Protection.*

¶Wherever reinforced concrete is used in buildings over 3 stories high, such reinforced concrete construction, all columns, girders, and beams shall have a protecting covering of at least 1 inch of non-combustible material

on all exposed surfaces, over and above the thicknesses and sizes required structurally in these reinforced concrete members. Cinder concrete, clay tiles, or plaster on wire lath are acceptable materials for this fire protection.

SEC. 242. *Supervision.*

¶The execution of all reinforced concrete work shall be done under the direct and constant supervision of a competent foreman or superintendent.

¶These foremen or superintendents must be enrolled, examined, classified, and licensed by or at the instance of the Building Department. Examinations may be held at regular intervals and an eligible list kept of men classified as to ability to carry on the different grades of work, for no concrete construction shall be carried on save under the direction of one of these duly licensed superintendents of whose ability the Department must be thoroughly satisfied; and a first-class, important building shall not be superintended by one who is qualified only to look after a second-class, inferior building.

¶Further, these superintendents must report the progress, condition, and character of the work in their charge at least once a week to the Building Department. They are to be virtually employes or inspectors of the Department but paid by the owners or builders of the buildings. They are to be held responsible to the Department for that work and must report any attempted violation of these rules of which they may in any way become cognizant. In the event of their carelessness with the work in their charge or any connivance in the evasion of these requirements, or other wrong doing or incompetence, the Building Department may discharge them, suspend them, remove them, place them upon less important work or revoke their license entirely and bar them from any such superintendence in the City.

CHAPTER XVI

REINFORCED TERRA COTTA HOLLOW TILE

SEC. 243. The term reinforced hollow tile is hereby defined to mean a system of hollow burned clay tile in combination with reinforced concrete, in which combination the hollow tile may be used to resist compressive and shearing stresses subject to the following provisions:

¶The provisions relating to reinforced concrete construction shall hold as far as applicable to this system.

¶All tile to be hard burned terra cotta tile of uniform quality, free from shrinkage cracks, with true beds and having an ultimate compressive strength of not less than 3,000 pounds per square inch of net area of surface tested.

¶The following stresses and values shall not be exceeded: Extreme fiber stress (compressive) on hollow tile, 500 pounds per square inch.

¶Shearing stress on hollow tile, 200 pounds per square inch.

¶Adhesion between tile and 1:2:4 concrete to 1:3 cement mortar, 40 pounds per square inch.

¶Ratio of modulus of elasticity of steel to that of tile with cement mortar joints, 10.

SEC. 244. *Special Provisions as to Workmanship in Reinforced Hollow Tile Construction.*

¶The hollow tile shall be thoroughly soaked with water at the time concrete is poured and be kept drenched for at least thirty-six hours afterwards. The joints between tiles shall be staggered, buttered, and slushed full of mortar consisting of one (1) part of Portland cement and three (3) parts of clean, sharp sand, thoroughly mixed.

SEC. 245. *Terra Cotta Tile Columns.* See Section 205.

SEC. 246. *Special Provisions as to Workmanship in Tile Column Construction.*

¶All terra cotta tile must be thoroughly wet before using and when used in columns must be set on end with the voids running vertically and with the webs in line of pressure.

¶All vertical joints must stagger and terra cotta blocks just be of proper dimensions to meet this condition as no broken tile will be allowed.

¶All work to be set plumb, with uniform horizontal joints, thickness to average ⅜ inch. The minimum time which shall elapse between the finishing of the work and before any load is placed thereon shall be not less than seven days.

SEC. 247. *Terra Cotta Tile Walls.*

¶Hollow tile may be used for building primary bearing walls, which are defined as walls that may be used to receive directly the loads from floors or roofs in addition to their acting as partition walls, provided the proportion between thickness of wall and free height between the floors does not exceed fifteen and the load including the weight of the construction does not exceed three hundred and fifty pounds per square inch of net sectional area of tile. The thickness of walls shall be calculated as the outside dimensions of the tile and each tile shall be full thickness of wall. The thickness of the plastering is not to be included as a part of the thickness of the wall. Walls having a thickness of 4 inches may be used when the height does not exceed 5 feet. The quality of the tile and mortar and special provisions as to workmanship as specified for terra cotta columns shall apply to terra cotta tile walls.

SEC. 248. *Terra Cotta Grain Bin Construction.*

¶Fireproof storage bin, grain elevators and grain warehouses may be built in cylindrical form with terra cotta tile of such height, diameter and thickness as is allowed by safe engineering practices, provided that the material shall not be stressed in excess of the limits prescribed in this chapter for walls and columns.

CONCRETE BUILDING BLOCKS

SEC. 249. Hollow concrete building blocks may be used for buildings five stories or less in height where their use is approved by the Building Department, provided, however, that the concrete shall be composed of at least one part of Standard Portland cement, and not to exceed five parts of clean, coarse, sharp sand or gravel, or a mixture of at least one part of Portland cement to five parts of crushed rock or other suitable aggregate. Provided, further, that this section shall not permit the use of any kind of hollow blocks in party walls. Said party walls must be built solid.

¶All concrete material shall be of such fineness as to pass a ½-inch ring and be free from dirt or foreign matter. The material composing all such blocks shall be properly mixed and manipulated and the hollow space in said blocks shall be properly proportioned.

SEC. 250. Where the face only is of hollow building blocks and the backing is of brick, the facing of hollow blocks must be strongly bonded to the brick either with headers 4 inches into the brickwork—every fourth course being a heading course—or with approved ties; no brick backing shall be less than 8 inches. Where the walls are made entirely of hollow blocks, but where said blocks have not the same width as the wall, every fifth course shall extend through the wall forming a secure bond. All walls where blocks are used, shall be laid up in Portland cement mortar; two parts sand, one part Portland cement.

SEC. 251. All hollow concrete building blocks, before being used in the construction of any building in the city, shall have attained an age of at least four weeks.

SEC. 252. Wherever girders or beams or joists rest upon walls so that there is a concentrated load on the block of over 1 ton, the blocks supporting the girder or joists must be made solid. Where such concentrated load shall exceed 3 tons, the blocks for two courses below and for a distance extending at least 18 inches each side of said girder, shall be made solid. Where the load on the wall from the girder exceeds 5 tons, the blocks for three courses beneath it shall be made solid with material similar to that in the blocks. Wherever walls are decreased in thickness, the top course of the thicker shall be solid.

¶Provided, always, that no wall, or any part thereof, composed of hollow concrete blocks shall be loaded to an excess of 8 tons per superficial foot of the area of such blocks, including the weight of the wall.

¶No block shall have an average crushing strength of less than 2,000 pounds per square inch when the blocks are tested (at twenty-eight days for concrete), where the strength is figured on the effective net section.

SEC. 253. All piers and buttresses that support loads in excess of 5 tons, shall be built of solid blocks for such distances below as may be required by the Building Department, and any lintels spanning over 4 feet 6 inches in the clear shall rest on solid blocks.

¶Provided, that no hollow building blocks shall be used in the construction of any building in the City unless the maker of said blocks has submitted the product to the full test required by the Building Department, which may also require a renewal of such tests from time to time to insure that the standard and character of the work is kept up.

¶A brand or mark of identification must be impressed in, or otherwise permanently attached to, each block for purpose of identification.

¶The manufacturer and user of any such hollow blocks, as are mentioned in this regulation, or either of them, shall at any and all times have made such tests of the cements or clays used in making such blocks, or such further tests of the completed blocks, or of each of these, at their own expense, and under the supervision of the Building Department, as it shall require.

SEC. 254. The cement used in making said concrete blocks shall be Portland cement, and must be capable of passing the minimum requirements as set forth in the "Standard Specifications for Cement" by the American Society for Testing Materials.

¶Any and all blocks, samples of which, on being tested under the direction of the Building Department, fail to stand (at twenty-eight days for concrete), the tests required by this regulation, shall be marked "condemned" by the manufacturer or user and shall be destroyed.

¶No concrete blocks shall be used in the construction of any building within the City until they have been inspected, and average samples of the lot tested, approved, and accepted by the Building Department.

SEC. 255. These regulations shall apply to all such new materials as are used in building construction, in the same manner and for the same purpose as stone, brick, and concrete are now authorized by the Building Laws, when said new material to be substituted departs from the general shape and dimensions of ordinary building brick.

¶Before any such material is used in buildings, an application for its use and for a test of the same must be filed with the Building Department. A description of the material and a brief outline of its manufacture and proportions of the materials used must be embodied in the application.

SEC. 256. The material must be subjected to the following tests: *transverse, compression, absorption, freezing, fire, and water.* Additional tests may be called for when, in the judgment of the Building Department, the same may be necessary. All such tests must be made as heretofore directed. The tests will be made at the expense of the applicant.

¶The results of the tests, whether satisfactory or not, must be filed with the Building Department. They shall be open to inspection upon application to the Building Department.

SEC. 257. For the purposes of the tests, at least twenty samples or test pieces must be provided. Such samples must represent the ordinary commercial product. They may be selected from stock by the Building Department.

TERRA COTTA BUILDING BLOCKS

SEC. 258. Terra cotta hollow tile may be used for bearing walls in buildings five stories or less in height, or for enclosure walls for skeleton structures of any height where the wall is carried from story to story, on steel or concrete beams or girders, where said use is approved by the Department. Provided that this section shall not permit the use of hollow tile in party walls, which must be built solid.

SEC. 259. All material must be well burned, dense material of approved quality and thickness.

SEC. 260. The thickness of the walls shall not be less than is required by law for brick walls, except where hollow tile blocks are used as a substitute for wood construction. The exterior walls shall be not less than the following thicknesses:

(*a*) For a one story building, 6 inches.

(*b*) For a two story building, first story 8 inches, second story 6 inches.

(*c*) For a three story building, first story 10 inches, second story 8 inches, third story 8 inches.

(*d*) For a four story building, first story 12 inches, second story 10 inches, third story 8 inches, fourth story 8 inches.

(*e*) For a five story building, first story 12 inches, second story 10 inches, third story 10 inches, fourth story 8 inches and fifth story 8 inches.

(*f*) The foundation walls shall be not less than 4 inches thicker than the first story walls, provided that no foundation wall shall be less than 12 inches thick.

SEC. 261. If the walls are exposed to the weather, all the hollow tile must be of dense material, and vitrified in burning, or they may be dense material, hard burned and covered on the exposed sides with at least 1 inch of Portland cement stucco or pebble dash. Such hollow tile to be well scored with dove-tailed grooves to receive cement coating.

SEC. 262. Wherever girders or beams rest upon a wall so that there is a concentrated load on the hollow tile of over two tons, the tile supporting the girder or beam must be made solid by filling with Portland cement concrete of broken stone or gravel mixed 1:2:4 or by covering the openings with flat slabs or brick, and wherever walls are decreased in thickness the top course of the thicker wall must be made solid in the same manner.

SEC. 263. Provided, always, that no tile shall be loaded in excess of 300 pounds per square inch of net section in compression, if set on end, or 150 pounds per square inch, if set on the side.

SEC. 264. All piers and buttresses that support loads in excess of five tons shall be laid solid with Portland cement concrete.

SEC. 265. Lintels spanning over 4 feet 6 inches in the clear shall rest on tile filled solid with concrete.

SEC. 266. All hollow tile work shall be subject to the regular inspection provided for by this code for other masonry building materials. The ultimate crushing strength shall be at least seven times the load it is required to support

SEC. 267. All hollow tile used in walls or piers shall be set in mortar composed of one part Portland cement and three parts of clean sand.

CHAPTER XVII

STEEL AND WROUGHT-IRON CONSTRUCTION

SEC. 268. No part of a steel or wrought-iron column shall be less than ¼-inch thick.

SEC. 269. No wrought-iron or rolled-steel column shall have an unsupported length of more than forty times its least lateral dimension or diameter, except as prescribed in this Code, and also except in cases where the Building Department may specially allow a greater unsupported length.

SEC. 270. The ends of all columns shall be faced to a plane surface at right angles to the axis of the columns, and the connection between them shall be made with splice plates.

¶The joint shall be effected by rivets of sufficient size and number to transmit the entire stress, and the splice plates shall be equal in sectional area to the area of the column spliced.

SEC. 271. When the section of the columns to be spliced is such that splice plates cannot be used, a connection formed of plates and angles may be used, designed to properly distribute the stresses.

SEC. 272. No material, whether in the body of the column or used as lattice-bar or stay-plate, shall be used in any wrought-iron or steel-column of less thickness than $\frac{1}{32}$ of its unsupported width measured transversely between centers of rivets, or $\frac{1}{16}$ of the distance between centers of rivets in the direction of the stress.

SEC. 273. Stay-plates are to have not less than four rivets, and are to be spaced so that the ratio of the length to the least radius of gyration of the parts connected does not exceed 40; in this case the distance between the nearest rivets of two stay-plates shall be considered as the length.

SEC. 274. Steel and wrought-iron columns shall be made in one, two, or three story lengths, and the material shall be rolled in one length wherever practicable to avoid intermediate splices. In placing these columns in buildings they shall be "broken-jointed," the splices alternating to prevent hinging at floor levels.

SEC. 275. Where any part of the section of a column projects beyond that of the column below, the difference shall be made up by filling plates secured to, column by the proper number of rivets.

SEC. 276. Shoes of iron or steel, as prescribed for cast-iron columns, or built shoes of plates and shapes may be used to comply with the same requirements.

¶Nothing herein shall prohibit the use of a wrought-iron shell of standard thickness filled with concrete approved by the Building Department.

SEC. 277. Cast-iron columns shall be of good workmanship and material and have a diameter of not less than 5 inches and a shell of a thickness not less than $\frac{3}{4}$ inch, except that $\frac{5}{8}$ inch may be used for light construction.

¶These columns shall not have an unsupported length of more than 20 times their lateral dimension or diameter, except as stated in the tables of this Code, and except the same shall form a part of a staircase, and also except in such specific cases where the Building Department may specially allow a greater unsupported length.

¶The top and bottom flanges, seats, and lugs shall be of ample strength, reinforced by fillets and brackets; they shall be not less than 1 inch in thickness when finished.

¶All columns shall be faced at the ends to a plane surface at right angles to the axis of the column.

SEC. 278. Where cast-iron columns are placed vertically one on top of another, they shall be securely bolted together at the joints through flanges cast on the columns and a plate between the flanges. If the column is square or rectangular, the top flange shall project not less than $2\frac{1}{2}$ inches from the outer surfaces of the column on all sides, and the bottom flange of the column immediately above the same shall project as far as the top flange of the column below.

¶If the column is round or many sided, the top flange shall project not less than $2\frac{1}{2}$ inches at its least projection from the outer surface of the column, and be square or rectangular in shape, and the bottom flange of the column immediately above the same shall be of corresponding shape. and project as far as the top flange of the column below. Each flange shall be reinforced with a bracket placed centrally on the column and with fillets both on the bracket and the flange.

¶In case the column is placed on the dividing line of the lot upon which the Building is to be erected, the flanges on that side only may be omitted.

SEC. 279. Between the joints of cast-iron columns placed vertically over each other, there shall be in each case a solid cast-iron plate not less than

1¼ inches in thickness, of the same dimensions as the flanges of the columns and planed true on both sides; a plate of mild steel, not less than ⅝ inch thick, may be used instead of the cast-iron plate.

¶The columns shall be bolted together with bolts not less than ¾ inch in diameter passing through the two flanges and the intermediate plate, the bolts being of sufficient length to allow the nuts to be screwed up tightly; and as each column is placed in position, the bolts shall also be placed in position and the nuts shall be tightly screwed up. One bolt shall be placed at each corner of the plate and flanges and the number of bolts shall never be less than four. The holes for these bolts shall be drilled to a template.

¶Where cast-iron columns are placed vertically one on top of the other, the diameters shall be increased, in the case of round columns, not less than 1 inch for each two stories below the columns on the two stories above, and in the case of square or rectangular columns, the same ratio of increase shall follow on at least two sides of the columns in each two stories below the uppermost two columns of the vertical line. This increase in size shall apply to interior as well as to exterior columns.

SEC. 280. The core of a column below a joint shall not be larger than the core of the column above, and the metal shall be tapered down for a distance of not less than 6 inches.

SEC. 281. Wherever the core of a cast-iron column has shifted more than one-fourth the thickness of the shell, the strength shall be computed on the assumption that the thickness of the metal all around is equal to the thinnest part, and the columns shall be condemned and rejected if this computation shows the strength to be less than required by this Code.

SEC. 282. Wherever blowholes or imperfections are found in a cast-iron column which reduces the area of the cross-section at that point more than ten per cent, such column shall be condemned and rejected.

SEC. 283. Cast-iron posts or columns not cast with one open side or back, before being set up in place, shall have a ⅜-inch hole drilled in the shaft of each post or column by the manufacturer or contractor furnishing the same in order to exhibit the thickness of the castings; and any other hole or holes of a similar size which the Building Department may require, shall be drilled in the said posts or columns by the said manufacturer or contractor at their expense.

SEC. 284. Iron or steel shoes or plates shall be used under the bottom tier of columns when necessary to properly distribute the load on the foundation.

¶Shoes shall be planed on top.

SEC. 285. In all buildings hereafter erected or altered, where any iron or steel columns are used to support a wall or part thereof—whether the same be an exterior or an interior wall—and where columns, located below the level of the sidewalk, are used to support exterior walls or arches over vaults, the said column or columns shall be either constructed double, that is, an outer and an inner column, the inner column alone to be of sufficient strength to sustain safely the weight to be imposed thereon, and the outer column to be 1 inch shorter than the inner columns, or such other iron or steel column of sufficient strength shall be protected with not less than 4 inches of hard burned brickwork, terra cotta, concrete, or other approved fireproof material securely applied.

SEC. 286. If iron or steel posts are to be used as party posts in front of a party wall and are intended for two buildings, then the said posts shall not be less in width than the thickness of this party wall, nor less in depth than the thickness of the wall to be supported above.

¶Iron or steel posts in front of side, division, or party walls shall be made perfectly tight between the posts and walls with masonry.

¶Intermediate posts may be used, which shall be sufficiently strong, and the lintels thereon shall have sufficient bearings to carry the weight above with safety.

SEC. 287. Rivets in flanges shall be so spaced that the least value of a rivet for either shear or bearing is equal to or greater than the increment of strain due to the distance between adjoining rivets. All other rules given under riveting shall be followed. The length of rivets between heads shall be limited to four times the diameter. The compression flanges of plate girders shall be secured against buckling if their length exceed thirty times their width.

SEC. 288. If splices are used they shall be of such strength as to bring the members spliced up to the standard in either tension or compression.

¶Stiffeners shall be provided over supports and under concentrated loads; they shall be of sufficient strength, as a column, to carry the loads, and shall be connected with a sufficient number of rivets to transmit the stresses into the web plate. Stiffeners shall fit so as to support the flanges of the girders. If the unsupported depth of the web plate exceeds sixty times its thickness, stiffeners shall be used at intervals not exceeding one hundred and twenty times the thickness of the web.

SEC. 289. When rolled steel or wrought iron beams are used in pairs to form a girder, they shall be connected by bolts and iron separators at intervals of not more than 5 feet.

¶All beams 12 inches and over in depth shall have at least two bolts to each separator.

SEC. 290. Cast-iron lintels shall not be used for spans exceeding 8 feet.

¶Cast-iron lintels or beams shall not be less than ¾ inch in thickness in any of their parts.

SEC. 291. When the lintels or girders are supported at the ends by brick walls or piers, they shall rest upon cast-iron or steel plates, or stone templates of adequate strength to properly distribute the load on the bearings.

¶In all cases the safe loads shall not exceed those fixed by this Code.

SEC. 292. All rolled-steel and wrought-iron floor and roof beams used in buildings shall be of full weight, straight, and free from injurious defects.

SEC. 293. Holes for tie rods shall be placed as near the thrust of the arch as practicable.

¶The distance between tie rods in floors shall not exceed 8 feet, and shall not exceed eight times the depth of floor beams 12 inches and under.

SEC. 294. Channels or other shapes, where used as skewbacks, shall have a sufficient resisting moment to take up the thrust of the arch.

¶Bearing plates of metal or stone shall be used to reduce the pressure on the wall to the working stress.

SEC. 295. Beams resting on girders shall be securely riveted or bolted to the same where joined on a girder; tie straps of ½-inch net sectional area shall be used, with rivets or bolts to correspond.

¶Anchors shall be provided at the ends of all such beams bearing on walls.

SEC. 296. Under the ends of all iron or steel beams where they rest on the walls, cast-iron or steel templates shall be built into the walls.

¶Templates under ends of steel or iron beams shall be of such dimensions as to bring no greater pressure upon the brickwork than that allowed in this Code.

¶When rolled iron or steel floor beams, not exceeding 6 inches in depth, are placed not more than 30 inches on centers, no templates shall be required.

¶Granite or bluestone templates of not less than 5 inches in thickness may be substituted for iron or steel.

SEC. 297. All iron or steel trimmer-beam headers, and tail beams shall be suitably framed and connected.

¶The iron or steel girders, columns, beams, trusses, and all other iron

work of all floors and roofs shall be strapped, bolted, anchored, and connected to the walls.

¶All beams framed into and supported by other beams or girders shall be connected thereto by angles or knees of a proper size and thickness, and have sufficient bolts or rivets in both legs of each connecting angle to transmit the entire weight or load coming on the beam to the supporting beam or girder.

¶In no case shall the shearing value of the bolts or rivets or the bearing value of the connection angles, provided for in this Code, be exceeded.

SEC. 298. The distance from the center of a rivet hole to the edge of the material shall not be less than

⅝ inch for.....½ inch rivets
⅞ inch for.....⅝ inch rivets
1⅛ inches for.....¾ inch rivets
1½ inches for.....1 inch rivets

Wherever possible, however, the distance shall be equal to two diameters.

SEC. 299. All rivets, wherever practicable, shall be machine-driven. The rivets in connections shall be proportioned and placed to suit the stresses. The pitch of rivets shall never be less than three diameters of the rivet nor more than 6 inches. In the direction of the stress, it shall not exceed sixteen times the least thickness of the outside member. At right angles to the stress, it shall not exceed thirty-two times the least thickness of the outside member.

¶All holes shall be punched accurately, so that upon assembling a cold rivet will enter the hole without straining the material by drifting. Occasional slight errors shall be corrected by reaming.

¶The rivets shall fill the holes completely and the heads shall be hemispherical and concentric with the axis of the rivet.

¶Wherever required, gussets shall be provided of sufficient thickness and size to accommodate the number of rivets necessary to make a connection.

SEC. 300. Where riveting is not practicable or possible, connections may be effected by bolts. These bolts shall be of wrought iron or mild steel and they shall have U. S. Standard threads. The threads shall be full and clean, the nut shall be truly concentric with the bolt, and the thread shall be of sufficient length to allow the nut to be screwed up tightly.

SEC. 301. When bolts go through bevel flanges, bevel washers to match shall be used, so that head and nut of bolts are parallel.

SEC. 302. When bolts are used for suspenders, the working stresses shall

be reduced for wrought iron to 10,000 pounds and for steel to 14,000 pounds per square inch of net area, and the load shall be transmitted into the head or nut by strong washers, distributing the pressure evenly over the entire surface of the same.

SEC. 303. Turned bolts in reamed holes shall be deemed a substitute for field rivets, but the diametrical clearance shall not exceed $\frac{1}{64}$ inch if turned bolts are used. Column connections and main girder connections shall be riveted.

SEC. 304. Trusses shall be of such design that the stresses in each member can be calculated.

¶All trusses shall be held rigidly in position by efficient systems of lateral and sway-bracing struts, these being spaced so that the ratio of maximum limit of length to least radius of gyration, established by this Code, is not exceeded.

¶Any member of a truss subjected to transverse stress, in addition to direct tension or compression, shall have the stresses causing such strain added to the direct stresses coming on the member, and the total stresses thus formed shall in no case exceed the working stresses stated in this Code.

SEC. 305. For tension members, the actual net area only, after deducting rivet holes $\frac{1}{8}$ inch larger than the rivets, shall be considered as resisting the stress.

¶If tension members are made of angle irons riveted through one flange only, only that flange shall be considered in proportioning areas. Rivets shall be proportioned as prescribed in this Code.

SEC. 306. If the axes of two adjoining web members do not intersect within the line of the chords, sufficient area shall be added to the chord to take up the bending strains, or the web members shall be connected by plates so arranged that the axes of the web members prolonged will intersect on the axis of the chord.

SEC. 307. No bolts shall be used in the connections of riveted trusses, excepting when riveting is impracticable and then the holes shall be drilled or reamed.

SEC. 308. The bending stresses on pins shall be limited to 20,000 pounds for steel and 15,000 pounds for wrought iron.

SEC. 309. All compression members in pin-connected trusses shall be proportioned, using seventy-five per cent of the permissible working stress for columns. The heads of all eyebars shall be made by upsetting or for-

ging. No weld will be allowed in the body of the bar. Steel eyebars shall be annealed. Bars shall be straight before boring.

SEC. 310. All pin-holes shall be bored true, and at right angles to the axis of the members, and must fit the pin within $\frac{1}{32}$ inch. The distance of pin-holes from center to center for corresponding members shall be alike, so that, when piled upon one another, pins will pass through both ends without forcing.

SEC. 311. Eyes and screw ends shall be proportioned so that upon test to destruction, fracture will take place in the body of the member.

SEC. 312. All pins shall be accurately turned.

SEC. 313. Pin-plates shall be provided wherever necessary to reduce the stresses on pins to the working stresses prescribed in this Code. These pin-plates shall be connected to the members by rivets of sufficient size and number to transmit the stresses without exceeding working stresses.

SEC. 314. All rivets in members of pin-connected trusses shall be machine-driven. All rivets in pin-plates which are necessary to transmit stress shall be also machine-driven.

SEC. 315. The main connections of members shall be made by pins. Other connections may be made by bolts.

¶If there is a combination of riveted and pin-connected members in one truss these members shall comply with the requirements for pin-connected trusses; but the riveting shall comply with the requirements of this Code.

SEC. 316. All cast-iron or metal front plates shall be backed up or filled in with masonry of the thickness as provided for walls and piers in this Code.

SEC. 317. Where surfaces in riveted work come in contact with each other, they shall be painted before assembling.

¶Paint shall not be required for metal structural work which is to be thoroughly imbedded in concrete or cement grout applied directly against the metal except where surfaces in riveted work come in contact with each other.

¶All metal structural work that is not to be thoroughly imbedded in concrete or cement grout shall be cleaned of all scales, dust, dirt, and rust, and thoroughly coated with at least one coat of suitable paint; after erection, all such work shall be painted at least one additional coat of another color.

¶Cast-iron columns shall not be painted or covered until after inspection by the Building Department.

SEC. 318. All iron or steel used under water shall be inclosed in concrete.

CHAPTER XVIII

PUBLIC BUILDINGS, THEATERS, PLACES OF ASSEMBLAGE

SEC. 319. In all public buildings, or buildings of a public character, such as hotels, churches, theaters, restaurants, railroad depots, public halls, schools, and other buildings used or intended to be used for purposes of large public assemblage, amusement, or instruction, and including department stores and other business and manufacturing buildings where large numbers of people are congregated, the halls, doors, and stairways, seats, passageways, and aisles, and all lighting and heating appliances and apparatus shall be arranged as the Building Department shall direct to facilitate egress in cases of fire or accident and to afford the requisite and proper accommodation for the public's protection.

SEC. 320. All aisles and passageways in said buildings shall be kept free from camp-stools, chairs, benches, and other obstructions, and no person shall be allowed to stand in or occupy any of said aisles other than an employe, or policeman, or fireman, during any performance, service, exhibition, lecture, concert, ball, or any public assemblage.

SEC. 321. The Building Department at any time may serve a written or printed notice upon the owner, lessee, or manager of any of said buildings, directing any act or thing to be done or provided in or about the said buildings and the several appliances therewith connected—such as halls, doors, stairs, windows, seats, aisles, fire-walls, fire apparatus, and fire escapes—as it may deem necessary.

SEC. 322. Nothing herein contained, however, shall be construed to authorize or require any other alterations to theaters existing prior to the date of this Code than are specified in this chapter.

SEC. 323. Every theater or opera house or other building hereafter erected which is intended to be used for theatrical or entertainment purposes or for public resort or entertainments of any kind, for the accommodation of more than three hundred persons, shall be built to comply with the requirements of this chapter.

SEC. 324. No building, which, at the time of the passage of this Code, is not in actual use for theatrical or entertainment purposes, and no build-

ing hereafter erected, not in conformity with the requirements of this chapter, shall be used for theatrical or operatic purposes, or for public entertainments of any kind until the same shall have been made to conform to the requirements of this chapter.

SEC. 325. No building hereinbefore described shall be opened to the public for theatrical or entertainment purposes, or for public entertainments of any kind, until the Building Department shall have approved the same in writing as conforming to the requirements of this chapter, nor until the Building Department shall have certified in writing that all the appliances for the extinguishing of fire or guarding against the same, conform to this Code and to the special requirements of this Chapter and are in a complete and satisfactory working condition.

¶Every such building shall have at least one front on the street and in such front there shall be suitable means of entrance and exit for the audience.

¶In addition to the aforesaid entrances and exits on the street, there shall be reserved for service in case of an emergency an open court or space on the side not bordering on the street, where said building is located on a corner lot; and on both sides of said building, where there is but one frontage on the street. The width of such open court or courts shall be not less than 6 feet where the seating capacity does not exceed one thousand people; exceeding one thousand and not more than eighteen hundred people, 7 feet in width; and exceeding eighteen hundred people, 8 feet in width. Said open court or courts shall begin on a line with or near the proscenium wall and shall extend the length of the auditorium proper, to or near the wall separating the same from the entrance lobby or vestibule.

SEC. 326. A separate and distinct corridor shall continue to the street from each open court, through such superstructure as may be built on the street side of the auditorium, with continuous walls of brick or fireproof materials on each side the entire length of said corridor or corridors and the ceiling and floors shall be fireproof.

¶Said corridor or corridors shall not be reduced in width to more than two feet less than the width of the open court or courts by any projection in the same; the outer openings shall be provided with doors or gates opening toward the street, said doors or gates to be regular approved "crowd-opening" doors and not otherwise fastened during any performance.

¶The said open courts and corridors shall not be used for storage purposes nor for any purpose whatsoever except for exit and entrance from

and to the auditorium and stage, and must be kept free and clear during performances.

¶The level of said corridor shall be graded to the sidewalk and made flush therewith at all points at the street entrances.

SEC. 327. The entrance of the main front of the building shall not be on a higher level from the sidewalk than four steps, but this shall not preclude the use of an additional number of steps at the street entrances to the sides or rear of the building, as may be necessary to overcome the difference in grades of sidewalks.

¶To overcome any difference of level in and between courts, corridors, lobbies, passages, and aisles on the ground floor, gradients shall be employed of not over 1 foot in 12 feet with no perpendicular risers.

SEC. 328. From the auditorium opening into the said open courts, or on the side street, there shall be not less than two exits on each side in each tier from and including the parquet and each and every gallery.

¶Each exit shall be at least 5 feet in width in the clear and provided with fire-doors constructed as hereinbefore described in this Code for fireproof doors. All of said doors shall open outwardly, and shall be fastened during the performance only with "crowd-opening" locks of an approved type.

SEC. 329. There shall be balconies not less than 3 feet in width in the said open court or courts at each level or tier above the parquet, on each side of the auditorium, of sufficient length to embrace the two exits; and from said balconies there shall be staircases extending to the ground level, with a rise of not over 8½ inches to a step and not less than 9 inches tread exclusive of the nosing.

¶The staircase from the upper balcony to the next below shall be not less than 30 inches in width in the clear, and from the first balcony to the ground 3 feet in width in the clear, where the seating capacity of the auditorium is for one thousand people or less; 3½ feet in the clear where exceeding one thousand and not more than eighteen hundred; 4 feet in the clear where exceeding eighteen hundred people.

SEC. 330. All the before-mentioned balconies and staircases shall be constructed of wrought iron or steel throughout, or of material of equivalent strength and incombustibility, and shall be of ample strength to sustain the load to be carried by them. They shall be covered with a metal hood or awning that shall be constructed in a manner approved by the Building Department; such staircases shall have a strong rail on each side.

¶Where one side of the building borders on a street, there shall be balconies

and staircases of like capacity and kind, as before-mentioned, carried to the ground.

SEC. 331. Nothing herein contained shall prevent a roof garden, art gallery, or rooms for similar purposes being placed above a theater or public building, providing the floor of the same forming the roof over such theater or building shall be constructed of iron or steel and fireproof materials, and that said floor shall have no covering boards or sleepers of wood, but be of tile or cement. Every roof over said garden or rooms shall have all supports or rafters of iron or steel, and be covered with glass or fireproof materials, or both, but no such roof garden, art gallery, or room for any public purpose shall be placed over or above that portion of any theater or other building which is used as a stage, except as is noted, herein. Requirements for exits shall be the same as for theaters. Or, a theater or other hall may be in the lower stories of a tall building provided all the foregoing requirements of exit and open courts, etc., be fulfilled, and provided there shall be absolutely no communication between that theater and the upper part or entrances or stairs—that the two be separate and distinct.

¶No workshop, storage, or general property room shall be allowed above the auditorium or stage or under the same, or in any of the fly-galleries unless all of such rooms or shops are located in the rear of or at the side of the stage, and in such cases they shall be separated from the stage by a brick wall not less than 12 inches in thickness, and the openings leading into said portions shall have self-closing standard fire-doors. And further, in every case of building above a stage the necessary skylight for the latter shall be at the foot of an open court, and all windows in such court shall have fixed wired glass sash, and such upper buildings will be all that is specified for fireproof construction in the most rigid and exacting sense of this Code.

¶No portion of any building hereafter erected or altered, used or intended to be used for theatrical or other such purposes as specified in this chapter, shall be occupied or used as a hotel, lodging house, factory, workshop, or manufactory, or for stage purposes, except as herein specially provided for and specially approved of by the Building Department. Said restriction relates not only to that portion of the building which contains the auditorium and the stage but applies to the entire structure in conjunction therewith.

¶No store or room contained in the building, or the offices, stores, or apartments adjoining, as aforesaid, shall be let or used for carrying on any business dealing in any highly inflammable article or material, except under

such conditions as may be prescribed by the Building Department under authority of a written permit issued by said Department, or for manufacturing purposes.

¶No lodging accommodations shall be allowed in any part of the building communicating with an auditorium.

SEC. 332. Interior walls built of fireproof materials shall separate the auditorium from the entrance vestibule and from any room or rooms over the same, also from any lobbies, corridors, refreshment, or other rooms; and in all such walls, the window and door frames and all sash and doors shall be fireproof; the window frames and sash shall be metal, of standard construction, and the sash shall be made stationary and shall be glazed with wire glass not less than ¼ inch in thickness, each pane or unit measuring not more than 24 by 30 inches; the doors shall be made to close automatically and shall be of standard pattern and make in every respect

SEC. 333. All staircases for the use of the audience shall be inclosed with walls of brick, or of fireproof materials approved by the Building Department in the stories through which they pass, and the openings to said staircases shall have self-closing fire-doors. No door shall open immediately upon a flight of stairs, but a landing, at least the width of the door, shall be provided between such stairs and such door, and such stairs shall lead directly into fireproof lobbies or vestibules that open to the street or courts.

SEC. 334 A fire-wall, built of brick, not less than 12 inches in any portion of same, shall separate the auditorium from the stage, and the same shall extend at least 4 feet above the stage roof—or the auditorium roof, if the latter be the higher—and shall be coped.

SEC. 335. Above the proscenium opening there shall be an iron or concrete girder of sufficient strength to safely support the load above, and the same shall be covered with fireproof material not less than 4 inches in thickness.

¶Should there be constructed an orchestra over the stage, above the proscenium opening, the said orchestra shall be placed on the auditorium side of the proscenium fire-wall, and shall be entered only from the auditorium side of said wall.

¶The moulded frame around the proscenium openings shall be formed entirely of fireproof materials; if metal be used, the metal shall be filled in solid with non-combustible material and securely anchored to the wall with iron.

SEC. 336. The proscenium opening shall be provided with a fireproof curtain of metal or of asbestos, or of other fireproof material approved by the Building Department; said curtain shall overlap the brick proscenium wall at each side not less than 12 inches, and shall slide vertically at each side within iron grooves or channels to a depth of not less than 12 inches. Said grooves or channels shall be securely bolted to the brick wall and shall extend to the height of not less than 3 feet above the top of a curtain when raised to its full limit.

¶Said curtain shall be suspended or hung by steel cables passing over wrought-iron brackets of sufficient strength and well-braced; the brackets shall be securely attached to the proscenium wall by through bolts with nuts and washers on the opposite side of the wall.

¶Said curtain shall be raised at the commencement of each performance, lowered after each act, and lowered at the close of the performance, and shall be operated by approved machinery for that purpose.

¶If the proscenium curtain be of asbestos, that material shall be reinforced with wire or wire spun in the asbestos, and at the bottom of the curtain shall be placed a rigid metallic rod or bar of proper weight, securely fastened to the curtain and covered over with like material as the curtain itself, to carry down the curtain by the weight of the said rod or bar when released.

¶The excess weight of the curtain shall be overcome by a check rope of cotton hemp, extending to the floor on both sides of the stage, so that the cutting or burning of this rope will release the curtain, which will then descend at its normal rate of speed. The proscenium curtain shall be placed at the nearest point at least 3 feet distant from the footlights.

SEC. 337. No doorway or opening through the proscenium wall, from the auditorium, shall be allowed above the level of the first floor; and such first-floor openings shall have self-closing, standard fire-doors at each side of the wall; and openings, if any, below the stage shall each have a self-closing, standard fire-door, and all of the said doors shall be hung so as to be opened from either side of the wall at all times.

SEC. 338. There shall be provided over the stage a metal skylight of an area or combined area at least $\frac{1}{12}$ of the area of said stage, and shall be fitted with sash made to open, and shall be glazed with glass not exceeding $\frac{1}{8}$ of an inch thick, and each pane thereof measuring not less than 300 square inches.

¶The whole of said skylight shall be so constructed as to open instantly on the cutting or burning of a hempen cord which shall be arranged to

hold the skylight closed. Immediately underneath the glass of said skylight, there shall be wire netting, but wire glass shall not be used in lieu of this requirement.

SEC. 339. The roof over the stage shall be provided with a shaft of galvanized iron extending from the ceiling line up through and at least 4 feet above the roof and shall have a raised cover at the top for the escape of smoke. The least inside diameter, or the least horizontal measurement, if the shaft be of other shape than circular, shall be 48 inches. At the bottom of this shaft, on a plane with the ceiling, shall be a galvanized sheet-iron door in two parts, each part separately hinged and kept closed by fusible links, so that in case of fire the doors will instantly open downward by their own weight.

SEC. 340. All that portion of the stage not comprised in the working of scenery, traps, and other mechanical apparatus, for the presentation of a scene, usually equal to the width of the proscenium opening, shall be built of iron or steel beams filled in between with fireproof material and all girders for the support of said beams shall be of wrought iron or rolled steel.

SEC. 341. The fly-galleries and the tie-galleries entire, including pin-rails, shall be constructed of iron or steel; the floor of said galleries shall be composed of iron or steel beams, filled in with fireproof materials, and no wood boards or sleepers shall be used as covering over beams, but the said floors shall be entirely fireproof.

SEC 342. The gridiron or rigging loft shall have a lattice iron floor and be readily accessible by iron stairways, and shall also have a means of escape to the roof and thence to other buildings or to the ground.

SEC. 343. All stage-fixed or "house" curtains, and decorations made of combustible material, and all woodwork on or about the stage shall be painted or saturated with some non-combustible material, or otherwise rendered at least moderately safe against fire.

SEC. 344. The fronts of each gallery shall be entirely formed of fireproof materials, except the capping, which may be made of wood.

SEC. 345. The ceiling of the auditorium and under each gallery shall be entirely formed of fireproof materials.

SEC. 346. All lathing, wherever used, shall be of wire or other metal on metal studding.

SEC 347. The partitions in that portion of the building which contains the auditorium, the entrance, and the vestibule, and every room and passage,

devoted to the use of the audience, shall be constructed of fireproof materials, including the furring of outside or other walls.

¶None of the walls or ceiling shall be covered with wood sheathing, wood wainscoting, canvas, or any combustible material.

SEC. 348. Actors' dressing rooms shall not be placed on the stage, under the stage, over the stage, on the fly-galleries, or under the auditorium, but shall be placed in a separate section provided for that purpose, unless, if in such locations, they be especially protected and as may be approved by the Department.

¶The walls separating said section containing the actors' dressing room from the stage shall not be less than 12 inches in thickness, and the opening therefrom to the stage shall be protected with standard, self-closing fire-doors.

¶The partitions dividing dressing rooms, together with the partitions of every passageway from the same to the stage, and all other partitions on or about the sides of the stage, or fireproof partition thereof, shall be constructed of fireproof material approved by the Building Department. All doors in any of said partitions shall be standard fire-doors.

SEC. 349. All dressing rooms shall have an independent exit leading directly into a court or street, and shall be ventilated by windows in the external wall.

SEC. 350. All shelving and cupboards in each and every dressing room, property room, or other storage rooms, shall be constructed of metal, slate, or some fireproof material.

SEC. 351. All windows, where accessible, except as otherwise specified in this chapter, shall be arranged to open, so that firemen may have access through them to the building.

¶None of the windows in outside walls shall have fixed sashes, fixed iron grills, or bars; these may be arranged to hinge or lock, but must be left unlocked during performances.

SEC. 352. All seats in the auditorium, excepting those contained in boxes, shall be not less than 32 inches from back to back, measured in a horizontal direction, and firmly secured to the floor. No seat in the auditorium shall have more than six seats intervening between it and an aisle, on either side.

SEC. 353. No stool or seat shall be placed in any aisle.

SEC. 354. All platforms in galleries formed to receive the seats shall be not less than 32 inches in width from back to back of seats.

SEC. 355. All aisles on the respective floors in the auditorium, having seats on both sides of same shall be not less than 3 feet wide where they begin, and shall be increased in width towards the exits in the ratio of 1½ inches to 5 running feet. Aisles having seats on one side only, shall be not less than 2½ feet wide at their beginning, and increased in width the same as aisles having seats on both sides.

SEC. 356. The aggregate capacity of the foyers, lobbies, corridors, passageways, and rooms for the use of the audience, not including aisle space between the seats, shall, on each floor or gallery, be sufficient to contain the entire number to be accommodated on said floor or gallery, in the ratio of 150 superficial feet of floor room for every one hundred persons.

SEC. 357. Gradients or inclined planes shall be employed instead of steps, where possible.

SEC. 358. Every theater accommodating three hundred persons shall have at least two exits, and where accommodating five hundred persons, at least three exits.

SEC. 359. Doorways of exits or entrance for the use of the public shall be not less than 5 feet in width, not including the fire-exit doorways, and for every additional one hundred persons, or fraction thereof in excess of five hundred, to be accommodated, an aggregate of 20 inches additional exit width must be provided.

¶All doors of exit or entrance shall open outwards and be hung to swing in such a manner as not to become an obstruction in a passage or corridor, and no such doors shall be closed or locked when the building is open to the public.

SEC. 360. Distinct and separate places of exit and entrance shall be provided for each gallery above the first gallery.

SEC. 361. A common place of exit and entrance may serve for the main floor of the auditorium and the first gallery, provided its capacity be equal to the aggregate capacity of the outlets from the main floor and the said gallery.

SEC. 362. No passage leading to any stairway communicating with any entrance or exit, not including fire exits, shall be less than 4 feet in width in any part thereof.

SEC. 363. All stairs within the building shall be constructed of fireproof material throughout, as is elsewhere required in this Code.

¶Stairs from balconies and galleries shall not communicate with the basement or cellar.

¶All stairs shall have treads of uniform width and risers of uniform height throughout in each flight.

SEC. 364. No stairways from galleries shall be less than 4 feet in width. Where accommodation is provided in a gallery for more than one hundred people, there shall be at least two stairways extending to the ground and arranged on opposite sides of the gallery, and for every additional fifty people to be accommodated, 6 inches shall be added to the width proportionately divided between the two flights.

¶The width of all stairs shall be measured in the clear, between handrails.

¶In no case shall the risers of any stairs exceed 7½ inches in height, nor shall the treads, exclusive of nosings, be less than 10½ inches wide in straight stairs.

¶No circular or winding stairs for use of the public shall be permitted.

SEC. 365. Where the seating capacity is for more than one thousand people, there shall be at least two independent staircases, with direct exterior outlets provided for each gallery in the auditorium. Where there are not more than two galleries, the stairs shall be located on opposite sides of said gallieries. Where there are more than two galleries, one or more additional staireases shall be provided, the outlets from which shall communicate directly with the principal exit or other exterior outlets.

SEC. 366. At least two independent, direct, exterior outlets shall be provided for the service of the stage and shall be located on opposite sides of the same.

SEC. 367. All inside stairways leading to the upper galleries of the auditorium shall be inclosed on both sides with walls of fireproof materials. Stairs leading to the first or lower gallery may be left open on one side, in which case they shall be constructed as herein provided for similar stairs leading from the entrance hall to the main floor of the auditorium. But in no case shall stairs leading to any gallery or boxes be left open both sides.

SEC. 368. When straight stairs turn directly on themselves, a landing of the full width of both flights shall be provided, without any steps. The outer line of landings shall be curved to a radius of not less than 2 feet, to avoid square angles. Stairs turning at an angle shall have a proper landing without winders introduced at said turn.

SEC. 369. In stairs where two flights connect with one main flight, no winders shall be introduced and the width of the main flight shall be at least equal

to the aggregate width of the side flights. All stairs shall have proper landings introduced at convenient distances.

SEC. 370. All inclosed staircases shall have, on both sides, strong hand-rails firmly secured to the wall, about 3 inches distant therefrom and about 3 feet above the stairs, but said hand-rails shall not run on level platforms and landings where the same are of greater length than the width of the stairs.

SEC. 371. All staircases 8 feet and over in width shall be provided with a center hand-rail of metal, not less than 2 inches in diameter, placed at a height of about 3 feet above the center of the treads and supported on wrought metal or brass standards of sufficient strength, placed not nearer than 4 feet nor more than 6 feet apart, and securely bolted to the treads or risers of stairs or both, and at the head of each flight of stairs, on each landing, the post or standard shall be at least 6 feet in height, to which the rail shall be secured.

SEC. 372. Every steam boiler which may be required for heating or other purposes shall be located outside of the building, either under the sidewalk or in an extension, but in no case under or within any portion of the building used for theatrical purposes, and the space allotted to the same shall be inclosed by walls of masonry on all sides, and the ceiling of such place shall be constructed of fireproof materials. All doorways in said walls connecting with the building shall have standard, automatic, sliding fire-doors.

SEC. 373. No floor register for heating, ventilating, or other purposes shall be permitted except where the auditorium is heated from a plenum-chamber that in turn is completely inclosed, fireproof, and separated from the boiler or other heating apparatus.

¶No coil or radiator shall be placed in any aisles or passageway used as an exit, and thereby reduce the same to less than the width required by this chapter; but all said coils and radiators shall be placed in recesses formed in the walls or partitions to receive the same or suspended overhead.

¶All supply, return, or exhaust pipes shall be properly incased where passing through floors or near woodwork.

SEC. 374. Standpipes of not less than 4 inches in diameter shall be provided with hose connections by angle valves discharging downwards as follows: One on each side of the auditorium in each tier; one on each side of the stage in each tier; one within 10 feet of the door of the property room; one within 10 feet of the door of the carpenter's shop and scenery storage room.

¶All of such standpipes and hose connections shall be kept clear of obstructions.

¶Said pipes shall be separate and distinct, receiving their supply of water direct from the street main, one for the auditorium and one for the stage, and shall be fitted with regulation couplings of the fire department, and be ready with attached hose for immediate use at all times during a performance in said building. When the pressure of the street water service is not sufficient to provide an efficient working pressure at the hose nozzle or sprinkler outlets, then the standpipes shall be kept filled with water by means of an automatic pump or pumps of sufficient capacity to supply all the fire lines connected therewith or by means of suitable steel tanks on top of the building.

¶One spanner shall be located at each hose connection.

¶Pipes shall be kept constantly filled with water under pressure and be ready for immediate use at all times.

SEC. 375. In addition to the requirements contained in this chapter the standpipes shall have a Siamese steamer connection and conform to all other requirements contained in this Code covering standpipe installation.

SEC. 376. A sufficient quantity (not less than 50 feet in total length) of approved linen, cotton, rubber-lined, or rubber hose not less than 2½ inches in diameter, in not less than 50-foot lengths, shall be kept attached to each hose connection. Hose shall be fitted with washers and equipped with couplings and nozzles, the thread of which shall be uniform with that in use by the local Fire Department. And such hose must be renewed when tests show it to be defective or rotted, and all hose must be tested twice a year.

SEC. 377. The standpipe equipment above described shall be installed independently of and without connection to the automatic sprinkler system required under this chapter.

SEC. 378. A system of automatic sprinklers approved by the Building Department shall be installed throughout the entire stage section of the theater located in the rear of the proscenium wall, this to include under roof, under gridiron, under galleries, under the stage, in all dressing rooms, in all workshops, property rooms, and all other rooms and passageways on said stage; there shall also be a water curtain in front of the proscenium.

SEC. 379. There shall be an independent water supply to the sprinklers which shall consist of

(*a*) Automatic fire pumps of at least 500 gallons capacity; or

(*b*) Approved steel pressure tank of not less than 7,500 gallons capacity, located not lower than the highest line of sprinklers; or

(*c*) Direct supply from city water mains where the pressure is sufficient to maintain not less than 25 pounds at the highest line of sprinklers where the same are in operation.

SEC. 380. In addition to one or more of the above required supplies, there shall be a Siamese steamer connection placed on the outside of the building at each street front, installed as described in this Building Code, and with suitable iron plate with raised letters securely attached to the wall near the steamer connection reading "Stage Sprinklers."

¶The location and spacing of sprinkler heads and the schedule of pipe sizes shall conform to the standard recommended by the Board of Underwriters, which is hereby made a part of the requirements of this Code.

SEC. 381. There shall be kept in readiness for immediate use one 40-gallon cask filled with water and 6 fire pails on each side of the stage, under the stage, and on each fly-gallery; and a supply of fire pails in property and other store rooms and in each dressing room and each workshop; said casks and buckets shall be painted red and lettered—"For Fire Purposes Only."

SEC. 382. There shall also be provided six 3-gallon approved chemical fire extinguishers, at least four axes, two 20-foot hooks, two 15-foot hooks, and two 10-foot hooks on the stage, and such other appliances as may be required by the Building Department.

SEC. 383. Every portion of the building devoted to the uses or accommodation of the public, also all outlets leading to the streets, and including the open courts and corridors, shall be well and properly lighted during every performance and shall remain lighted until the entire audience has left the premises.

SEC. 384. There shall be one light, within a red globe or lantern, placed over each exit opening, on the auditorium side of the wall, which shall be kept lighted throughout the whole performance and until every person has left the auditorium. Approved hand lanterns and matches shall be kept at each exit.

SEC. 385. Gas mains and electric-light wires supplying the building shall have three independent connections as follows: One for the stage; one for the auditorium, excepting the exit lights therein; and the third for the halls, corridors, lobbies, exit lights, including the exit lights in the auditorium and such portions of the building used by the audience outside of the auditorium proper.

¶All gas and electric lights in the halls, corridors, lobbies, and other por-

tions of the building used by the audience, with the exception of the auditorium proper, but including the exit lights therein, shall be controlled by two separate switches or valves, one to be located in the lobby and the other to be so located as to be operated from the outside of the building.

¶Provision shall be made for shutting off all gas at a point outside of the building.

¶When interior gas lights are not lighted by electricity, other suitable appliances, to be approved by the Building Department, shall be provided.

SEC. 386. All suspended or bracket lights surrounded by glass, in the auditorium or in any part of the building devoted to the public, shall be provided with proper wire netting.

¶No gas or electric light shall be recessed in the walls, woodwork, ceilings, or in any part of the building, unless protection is afforded by fireproof materials.

¶All lights in passages or corridors in said buildings, and wherever else deemed necessary by the Building Department shall be guarded with proper wire network.

¶The footlights, when not electric, in addition to the wire network, shall be guarded with strong wire guard and chain drawn taut, placed not less than 2 feet distant from said footlights; and the trough containing said footlights shall be formed of and surrounded by fireproof materials.

¶All border lights shall be constructed according to the best-known methods and subject to the approval of the Building Department.

¶All ducts or shafts used for conducting heated air from the main chandelier, or from any other light or lights, shall be constructed of metal and made double with an air space between, or some other approved fireproof material may be used.

SEC. 387. All stage lights shall have strong metal wire guards or screens, not less than 8 inches in diameter, so constructed that any material in contact therewith shall be out of reach of the flames of said stage lights, and such guards or fixtures shall in all cases be soldered to the fixture.

SEC. 388. The bridge calcium lights at the sides of the proscenium shall be inclosed in front and on the side by galvanized iron so that no drop can come in contact with the lights. Electric calciums so-called are included in the above requirement.

SEC. 389. The standpipes, gas pipes, electric wires, hose, footlights, and all apparatus for the extinguishing of fire or guarding against the same, as specified in this chapter, shall be installed to the satisfaction of and be in charge of and under the control of the Building Department, and the

said Department is hereby directed and has the authority to see that the arrangements in respect thereto are carried out, enforced, and maintained, and the special house fireman paid by the theater shall be under the orders of the Department and shall report any non-compliance with its requirements to said Department.

SEC. 390. A diagram or plan of each tier, gallery, or floor showing distinctly the exits therefrom, each occupying a space not less than 15 square inches, shall be printed in black lines in a legible manner on the program of the performance.

SEC. 391. Every exit shall have over the same on the inside the word EXIT painted in legible letters, not less than 8 inches high, in red, and there shall be a strong light behind the same.

SEC. 392. All moving-picture theaters or such places of amusement shall conform, according to size, with the true intent of this code as applied to buildings generally and theaters more specifically. The operating box shall be fireproof and shall not be placed where it will interfere with the proper and ample exit of the spectators, and there shall be sufficient extinguishing appliances and a skilled operator always at hand to put out any blaze that may occur in such operating box. All films shall be kept in fireproof cabinets. Every detail of such building shall be shown on proper plans and approved by the Building Department before it is carried into execution, and there must be no wood in or near the operating box or the store room.

SEC. 393. All existing theaters, halls, and such buildings of public assembly shall, within one year from the date of approval of this Code, be put in such shape as to conform with these foregoing requirements as far as it is possible without tearing their structural parts to pieces. After one year, if such improvements have not been made, the buildings shall be condemned by this Department and permanently closed.

¶Further, if their capacity is greater than one thousand and in the opinion of the Department it be deemed impossible to so change them as to make them safe and conform with the spirit of this Code, then they shall be permitted to run for six months after the approval of this Code and then permanently closed.

¶And further, in any event, all existing theaters, schools, churches, halls, hotels, or other buildings where many people live or assemble, of the classification that is herein called "fireproof," either as to height or occupancy, must be made to conform in structure, side alleys, width of aisles, and in what might be called absolute essentials of this Code, within two years or be then permanently closed.

CHAPTER XIX

IN GENERAL

SEC. 394. More specifically:

¶Schools shall have their stairs immediately at the outer walls, properly inclosed and with fire doors at each story but so that the foot of the stairs shall be immediately adjacent to or part of an exit from the building to the street, alley, or yard.

SEC. 395. Stores, hotels, and apartments shall have no inner inclosed court over two stories high and that only on the street level and second story. And in all such buildings there must be a means of direct exit from the lowest point reached by the public stairs and elevators to the street, direct and uncommunicating with any portion in which there could be a fire and through which a crowd might have to pass in exit from the upper stories.

SEC. 396. No room for habitation, sleeping, or office shall be less in area than 60 square feet, and every sleeping room shall have a window of at least 12 square feet, either upon a street, alley, yard, or open court of not less than 20 square feet.

SEC. 397. In all buildings other than churches, theaters, and such assembly halls, the areas of undivided units of space cannot exceed those in the requirements of the National Board of Underwriters, Table III, and in offices and apartments and hotels there should be some cut-off for every 2,500 square feet in room spaces.

SEC. 398. All buildings used as hotels, apartments, flats, tenements, or dwellings, hereafter built upon inside lots shall have at least 25 per cent of such lot space devoted to open light courts, yards, alleys, or such open light spaces, open to the ground or at least to the second story level. Such buildings over 50 feet wide upon corner lots must have 10 per cent of space so open.

¶No light court shall be less than 20 square feet in area, vent shafts of lesser area shall not be used for lighting purposes. All light courts shall be proportioned to the rooms they serve and the height of the building and if deemed insufficient by the Department the plans must be changed before a permit is issued.

TABLE III

Limits of Undivided Floor Areas

Non-Fireproof Construction		Non-Fireproof Construction	
Any occupancy. Height limited to 45 feet Area, *without* Automatic Sprinkler Protection		Any occupancy. Height limited to 45 feet Area, *with* Automatic Sprinkler Protection (being an increase of 50 per cent over the unsprinkled area)	
Fronting on one street only	5000 sq. ft.	One street front	7500 sq. ft.
Fronting on two streets, that is, extending through from street to street	6000 sq. ft.	Two street fronts	9000 sq. ft.
Corner building, fronting on two streets	6000 sq ft.	Corner building, two street fronts	9000 sq. ft.
Fronting on three streets	7500 sq. ft.	Three street fronts	11250 sq. ft.

Fireproof Construction		Fireproof Construction	
Occupancy: stores, warehouses, and factories. Height not exceeding 55 feet Area, *without* Automatic Sprinkler Protection		Occupancy: stores, warehouses, and factories. Height not exceeding 55 feet Area, *with* Automatic Sprinkler Protection (being an increase of 33⅓ per cent over the unsprinkled area)	
Fronting on one street only	10000 sq. ft.	One street front	13333 sq. ft
Fronting on two streets, that is, extending through from street to street	12000 sq. ft.	Two street fronts	16000 sq. ft.
Corner building, fronting on two streets	12000 sq. ft.	Corner building, two street fronts	16000 sq. ft.
Fronting on three streets	15000 sq. ft.	Three street fronts	20000 sq. ft.

Fireproof Construction		Fireproof Construction	
Occupancy: stores, warehouses, and factories. When not over 80 feet high Area, *without* Automatic Sprinkler Protection, same as for non-fireproof construction		Occupancy: stores, warehouses, and factories. When not over 140 feet high Area, *with* Automatic Sprinkler Protection (being an increase of 33⅓ per cent over the unsprinkled area)	
Fronting on one street only	5000 sq. ft.	One street front	6666 sq. ft.
Fronting on two streets, that is, extending through from street to street	6000 sq. ft.	Two street fronts	8000 sq. ft.
Corner building, fronting on two streets	6000 sq. ft.	Corner building, two street fronts	8000 sq. ft.
Fronting on three streets	7500 sq. ft.	Three street fronts	10000 sq. ft.

Fireproof Construction		Fireproof Construction	
Any occupancy. When not over 200 feet high Area, *without* Automatic Sprinkler Protection, same as for fireproof construction limited to 55 feet with Automatic Sprinkler Protection		Occupancy: other than stores, warehouses, and factories. When not over 200 feet high Area, *with* Automatic Sprinkler Protection (being an increase of 50 per cent over the unsprinkled area)	
Fronting on one street only	13333 sq. ft.	One street front	20000 sq. ft.
Fronting on two streets, that is, extending from street to street	16000 sq. ft.	Two street fronts	24000 sq. ft.
Corner building, fronting on two streets	16000 sq. ft.	Corner building, two street fronts	24000 sq. ft.
Fronting on three streets	20000 sq. ft.	Three street fronts	30000 sq. ft.

SEC. 399. Internal water-closet rooms of not more than two fixtures per story will be permitted, but must be specially vented by a vent shaft of 20 square feet, and no one such toilet room may be vented into a light court that also serves sleeping rooms unless such court is at least of 40 square feet. Such toilet room windows must be 3 square feet in area or more.

SEC. 400. In every apartment house or tenement house hereafter erected, exceeding three stories and basement in height, every public hallway, *i. e.*, a corridor not within an apartment, shall have at least one window opening directly upon the street or upon a yard or court.

¶One at least of the windows provided to light each public hallway or part thereof, shall be at least 2½ feet wide and 5 feet high, measured between stop beads.

¶Any part of a hallway which is shut off from any other part of said hallway by a door or doors, shall be deemed a separate hall or separate hallway within the meaning of this Section.

¶In every apartment house or tenement house hereinafter erected exceeding three stories and basement in height, the aggregate area of windows to light or ventilate stair halls, *i. e.*, the public hallways which include the stairs, stair landings, and those portions of the hallways through which it is necessary to pass in going between the entrance floor and the roof, shall be at least 18 square feet for each floor.

¶There shall be provided for each story at least one of said windows, which shall be at least 2½ feet wide and 5 feet high, measured between the stop beads.

¶A sash door shall be deemed the equivalent of a window in public hallways and stair halls, provided that such door contains the amount of glazed surface prescribed for such windows.

SEC. 401. In every apartment house and tenement house a proper light shall be kept burning by the owner in the public hallways, near the stairs, upon the entrance floor, and upon the second floor above the entrance floor of said house, every night from sunset to sunrise throughout the year.

SEC. 402 In all apartments, hotels, tenements, and such buildings there shall be at least one water-closet for every fifteen occupants.

SEC. 403. All stores, apartments, hotels, theaters, and such public or semi-public buildings must have a means of reaching the basement from the street, and another means of escape from the basement in the case of fire shall also be provided.

SEC. 404. Proper protection shall be afforded the public as well as the men engaged in erecting a new building or repairing an old one. Sheltered sidewalks shall be provided; care shall be exercised in avoiding the dropping of material and in keeping dust, débris, and mortar out of the public's way; and in providing completed floor or staging at not over two stories below where men may be engaged in work; and in providing sufficiently strong scaffolding, safety devices on elevators, etc. The Building Department will be the judge as to what is and what is not proper protection and its orders in the premises must be immediately complied with.

SEC. 405. Grain elevators, ice houses, pier sheds, exhibition buildings, and all such structures as are not herein specifically covered and mentioned, may be of especial construction and for special purposes but must conform to the spirit of this Code, and their plans had better be made only after consultation with the Building Department. A grain elevator, for instance, though planned all of metal or concrete, will have to be made more fire-resisting to be built in the *inner* fire limits than for the *outer* fire limits.

SEC. 406. Tanks containing more than 500 gallons of water or other fluid hereafter placed in any story, or on the roof, or above the roof of any building now or hereafter erected, shall be supported on iron or steel beam, of sufficient strength to safely carry the same.

¶And the beams shall rest at both their ends on brick walls, or on iron or steel girders, or on iron or steel columns, or on piers of masonry—a continuous and sufficient support to a suitable foundation. These supports, if of metal, must be kept well painted and rust-proof.

¶Underneath any said water tank or on the side near the bottom of the same, there shall be a short pipe or outlet, not less than 4 inches in diameter, fitted with a suitable valve having a lever or wheel handle to same, to discharge the weight of the fluid contents from the tank, in case of necessity, unless the tank water is to supply automatic sprinklers.

¶Such tanks shall be placed where practicable at one corner of a building, and shall neither be placed over nor near a line of stairs, unless the stairs are inclosed with brick walls of sufficient strength to support the added load of the tank and contents.

¶Covers on top of water tanks placed on roofs, if of wood, shall be covered with tin.

All wooden tanks shall be coopered with metal hoops, circular in section.

SEC. 407. All buildings shall be kept provided with proper metallic leaders for conducting water from the roofs in such manner as shall protect the walls and foundations of said buildings from injury.

¶In no case shall the water from the said leaders be allowed to flow upon the sidewalk, but the same shall be conducted by pipe or pipes to the sewer.

¶If there is no sewer in the street upon which such buildings front, then the water from said leader shall be conducted by proper pipe or pipes, below the surface of the sidewalk to the street gutter.

CHAPTER XX

PLUMBING, HEATING, AND LIGHTING

SEC. 408. Any person, persons, or corporation desiring to engage in the business of plumbing as a master plumber, or master plumbers, before receiving a license to do so, shall file in the office of the Building Department, a petition in writing, giving the name of the person, persons, firm, or corporation and the place of business of said person, persons, firm, or corporation petitioning to become a licensed master plumber or master plumbers, and agreeing that he or they will abide by the rules and regulations of the Building Department and the city ordinance. Before receiving a license the applicant shall execute and deposit in the office of the Building Department a good and sufficient bond, to be approved by said Building Department, and payable to the City in the sum of $1,000, conditioned that said applicant will indemnify and save harmless the City and the Building Department of and from all accidents or damages caused by him or them in any work done by virtue of his or their said license. Said petition shall be accompanied by a license fee of ten dollars, to be paid into the treasury of the City, whereupon said Building Department shall issue to said applicant a license to engage in the business of master plumber or master plumbers, said and all other licenses or permits issued by the Department are revocable by the Department for major infractions of this ordinance.

SEC. 409. The following terms shall have the meanings respectively assigned to them:

¶*Repair of Leaks* shall mean such repairs as are necessary to protect property but do not involve any change in construction.

¶*Y-Branches* shall mean a branch of sufficient angle to direct the flow and prevent backing up.

¶*Air Pipes* or *Back Air Pipes* shall mean air pipes from traps that extend toward the main soil pipe or the outer air and connect with not more than three traps.

¶*Vent Pipes* shall mean general lines of back air pipes connecting with more than three fixtures.

¶*Drain* shall mean that part of the drainage system of a building of 4 inches or more internal diameter between basement or cellar and the highest fixture in the building.

¶*Ventilation Pipe* shall mean the extension of the soil pipe from the highest fixture to and through the roof.

¶*Surface Drain* shall mean a connection with drain in the basement to allow egress of surface water or overflow.

¶*Fixture* shall mean any receptacle or outlet placed for the purpose of disposing of waste water or other matter and connecting with the waste, soil, or drain pipe of a building.

SEC. 410. Every plumber, before doing any work in any building, shall, except in the case of repair of leaks, file in the office of the Building Department, upon blanks for that purpose, an application for a permit, and a plan or sketch of the work to be performed; and no such work shall be done in any building without a written permit from the Building Department.

SEC. 411. The plumbing of every building shall be separately and independently connected outside the building with the public sewer, if such sewer is provided, or with a proper and sufficient private drain or sewer laid outside of the building, and if a sewer is not accessible, with a proper cesspool. Several buildings may have a common sewer connection if such connection is approved by the Building Department and the Superintendent of Sewers. No cesspool shall be placed nearer than 20 feet to any residence.

SEC. 412. Pipes or fixtures shall not be covered or concealed from view until approved by the Building Department who shall examine or test the same within two working days after notice that they are ready for inspection. Plumbing shall not be used unless, when roughed in, the waste vents, and back air pipes and traps are first tested by water or sufficient air pressure in the presence of an inspector, when such testing is practicable.

SEC. 413. The waste pipe of every independent sink, basin, bath-tub, water-closet, slop-hopper, urinal, or other fixture shall be furnished with a separate trap, which shall be placed as near as practicable to the fixture which it

serves. All connections on lead waste and back air pipes and on lead pipes to brass ferrules and soldering nipples shall be full size, wiped, soldered, branch, round, or flange joints. Soil and waste pipes shall have proper "T-Y" or "Y" branches for all fixture connections. No connections to lead bends for water-closets or slop sinks shall be permitted, except the required back air pipe where a continuous vent is not practicable.

SEC. 414. All closets shall be put on floor slabs of stone, slate, or cement and shall be sufficiently large to set on the main support of the floor.

SEC. 415. All earthenware traps must have heavy brass floor plates, soldered to the lead bends, or where brass or iron pipes are used, to be screwed to the same and bolted to the trap flange, and the joint to be made gas tight without the use of red or white lead or any similar substance or rubber washers, the use of which, in the making of said connections, is hereby prohibited, and no device for such connections will be permitted to be used unless it has been approved by the Building Department.

SEC. 416. Traps shall be protected from siphonage or air pressure by lead, galvanized iron, or brass air pipes of a size not less than 1½ inches for traps of 2 inches or less, and 2 inches for traps larger than 2 inches, and larger. Back air pipes shall connect with the top of traps or as near the top as practicable.

¶Air pipes for water-closet traps shall be connected to the highest point of bend or trap, and may be of 2-inch bore if for no more than four fixtures and less than 40 feet in length; and shall be of larger bore, if for more than four fixtures or more than 40 feet in length.

¶Air pipes shall be run as direct as practicable, and if of 1½ inches diameter, shall not exceed 30 feet in length. Two or more air pipes may be connected together or with a vent pipe; but in every such case the connection shall be above the top of the highest fixture.

SEC. 417. Diameters of vent pipes shall not be less than 2 inches for main vents through less than seven stories; 3 inches for water-closets on more than three floors and for other fixtures in more than seven stories. All vent pipes shall be increased 1 inch in diameter before passing through the roof. Vent lines shall be connected at the bottom with a soil or waste pipe or with the drain, in such a manner as to prevent accumulation of rust scale and to drip properly the water of condensation. Offsets shall be made at an angle of not less than 45 degrees.

SEC. 418. Soil pipes or iron waste pipes, vents, and back air pipes, shall be supported by clamps to the woodwork, by iron drive hooks to brick walls, or by bolted clamps to iron girders.

SEC. 419. Fixtures and waste pipes in chemical laboratories shall be installed in accordance with plans approved by the Building Department.

SEC. 420. The drainage of stable fixtures shall be constructed according to plans approved by the Building Department.

SEC. 421. In buildings where a series of bathrooms or kitchens are located directly over each other and have a common soil or waste pipe, the back air pipe required shall be a vent line connected with each outlet branch close to the water-closet connection or outlet from the sink trap, each branch vent to connect with the vent line above the top of the highest fixture on each floor; the vent line shall connect to the main vent line above the top of the highest fixture in the building. In the case of batteries of water-closets or other fixtures the special air-pipe from each trap may be omitted, provided that the soil or waste pipe, undiminished in size, is continued without any other fixture connection to a point above the roof, or re-vented into the main soil-pipe system above the top of the uppermost fixture.

SEC. 422. All drip or overflow pipes shall be extended to some place in open sight and in no case shall such pipe be connected directly with the drain pipe. No waste pipe from a refrigerator or other receptacle in which provisions are stored shall be connected with a drain or other waste pipe.

SEC. 423. Every water-closet or line of water-closets shall be supplied with water from a tank or cistern and shall have a flushing pipe of not less than 1¼ inches in diameter.

SEC. 424. In every building hereafter erected, there shall be a separate water-closet for each tenement of four rooms or more and at least one water-closet for every two tenements of less than four rooms, fifteen persons living, occupying, or employed therein; said water-closets shall be located in well-ventilated rooms with a suitable window opening into the outer air, or with a suitable ventilating shaft.

SEC. 425. Water-closets, sinks, or basins shall not be inclosed.

SEC. 426. Sinks and laundry tubs shall be made of non-absorbent material.

SEC. 427. The diameters of soil and waste pipes shall not be less than those given in Table IV, except that, with the approval of the Building Department, a 3-inch soil pipe may be used for one water-closet where it is not practicable to use a 4-inch pipe.

TABLE IV

Soil and Waste Pipe Diameters

Soil pipes	4 inches
Main waste pipes excepting as otherwise specified	2 inches
Main waste pipes for kitchen sinks on four or more floors	3 inches
Branch waste pipes for laundry tubs	1½ inches
Branch waste pipes for kitchen sinks	1½ inches
Branch waste for urinals	1½ inches
No branch waste for other fixtures shall be less than	1½ inches

SEC. 428. Brass ferrules shall be of the best quality, bell-shaped, extra heavy cast brass, not less than 4 inches long and 2½ inches, 3½ inches, and 4½ inches in diameter, and shall be of not less than the weights given in Table V.

TABLE V

Brass Ferrule Data

Diameters	Weights
2½ inches	1 pound 0 ounces
3½ inches	1 pound 12 ounces
4½ inches	2 pounds 8 ounces

NOTE 1½-inch ferrules shall not be used.

SEC. 429. Soldering nipples shall be of heavy cast brass or of brass pipe, iron pipe size. If cast, they shall be of not less than the weights given in Table VI.

TABLE VI

Soldering Nipple Data

1½ inches	0 pounds 8 ounces
2 inches	0 pounds 14 ounces
2½ inches	1 pound 6 ounces
4 inches	3 pounds 8 ounces

SEC. 430. Where clean-outs are used, the screw cap shall be of brass, extra heavy, and not less than ⅛ of an inch thick. The engaging parts shall have not less than six threads of iron pipe size, and shall be tapered. Clean-outs shall be of full size of trap up to 4 inches in diameter and not less than 4 inches for larger sizes.

¶The screw cap shall have a solid square or hexagonal nut, not less than 1½ inches high, with at least a diameter of 1½ inches. The bodies of brass

clean-out ferrules shall be at least equal in weight and thickness to the calking ferrule for the same size of pipe.

SEC. 431. The use of lead pipe is restricted to short branches of the soil and waste pipes, bends, and traps, and roof connections of inside leaders.

SEC. 432. Lead soil and waste pipes shall not be less than the average thick, ness and weight per linear foot as given in Table VII.

TABLE VII

Lead Pipe Data

Diameter	Thickness	Weight per Linear Foot
1½ inches	.14 inches	3.50 pounds
2 inches	.15 inches	4.75 pounds
2½ inches	.20 inches	5.74 pounds
3 inches	.21 inches	7.54 pounds
3½ inches	.22 inches	9.00 pounds
4 inches	.23 inches	10.66 pounds
4½ inches	.24 inches	12.34 pounds
5 inches	.25 inches	14.50 pounds
6 inches	.28 inches	18.76 pounds
7 inches	.30 inches	23.27 pounds
8 inches	.32 inches	28.18 pounds
9 inches	.34 inches	33.70 pounds
10 inches	.36 inches	40.06 pounds
11 inches	37 inches	45.02 pounds
12 inches	.37 inches	48.98 pounds

SEC. 433. Brass pipe for soil, waste, vent, and back-air pipes shall be thoroughly annealed, seamless, drawn-brass tubing, of not less than No. 13 Stubbs gauge.

SEC. 434. No slip joints or unions shall be used on traps, waste, vent, or back air pipes. Threaded connections on brass traps shall be of the same size as pipe threads for the same size pipe and shall be tapered. Connections between lead and iron shall be made by brass sleeves or screw nipples wiped to the lead and calked or screwed into the iron.

SEC. 435. The average thicknesses and weights per linear foot for brass pipe shall be used as given in Table VIII.

SEC. 436. Cast-iron pipes shall be uncoated, sound, cylindrical, and smooth, free from cracks and other defects, of uniform thickness and of the grade known to commerce as "extra heavy." If buried under ground, they shall be coated with asphaltum or red lead.

TABLE VIII

Brass Pipe Data

Diameter	Thicknesses	Weight per Linear Foot
1½ inches	.14 inches	2.84 pounds
2 inches	.15 inches	3.82 pounds
2½ inches	.20 inches	6.08 pounds
3 inches	.21 inches	7.92 pounds
4 inches	.23 inches	11.29 pounds
4½ inches	.24 inches	13.08 pounds
5 inches	.25 inches	15.37 pounds
6 inches	.28 inches	19.88 pounds

SEC. 437. Cast-iron pipe, including the hub, shall weigh not less than the average weights per linear foot as given in Table IX.

TABLE IX

Cast-Iron Pipe Data

Diameter	Weights per Linear Foot
2 inches	5½ pounds
3 inches	9½ pounds
4 inches	13 pounds
5 inches	17 pounds
6 inches	20 pounds
7 inches (not stock size)	27 pounds
8 inches	33⅓ pounds
10 inches	45 pounds
12 inches	54 pounds

SEC. 438. All joints shall be made with picked oakum and molten lead run full, and shall be made gas tight. No cement joints or connections between iron and cement or tile pipe shall be made within 2 feet of any building.

SEC. 439. Galvanized wrought-iron pipe shall be of not less than the thickness and the weight per linear foot as given for lead piping.

¶The threaded part of the pipe, if less than 1½ inches long, shall be of the thickness and weight known as "extra heavy" or "extra strong."

SEC. 440. Fittings on wrought-iron vent pipes shall be galvanized, recessed, cast-iron threaded fittings. Fittings for "plumbers' tubing" shall be heavy weight with sharp threads.

¶Fittings for waste or soil pipes of wrought-iron or brass shall be galvanized wrought iron, cast iron, or brass, recessed and threaded drainage fittings, with smooth interior waterway and threads tapped, so as to give uniform grade to branches of not less than ¼ of an inch per foot.

¶All joints on wrought-iron or brass pipe shall be screwed joints made up with red lead, and any burr formed in cutting shall be carefully reamed out.

SEC. 441. Drain and connecting ventilation pipes, vents, and back air pipes shall be of sufficient size and shall be made of extra heavy cast-iron pipe if underground; and if above ground shall be made of extra heavy cast-iron, galvanized wrought-iron of standard weight, or, if not less than No. 13 Stubbs gauge, brass pipe within the building, except that lead pipes may be used for short connections exposed to view. Cast-iron drains shall extend not less than 2 feet from the outside face of the wall, beyond and away from the building.

SEC. 442. Drain pipes above ground shall be secured by irons to walls, suspended from floor timbers by strong iron hangers, or supported on brick, stone, or concrete piers. Proper man-holes shall be supplied to reach clean-outs and traps. Every drain pipe shall have a fall of not less than ¼ inch per foot, and shall be extended from a point 2 feet outside the outside face of the wall, unobstructed, to and through the roof, undiminished in size, and to a height not less than 2 feet above the roof, and not less than 1 foot above the top of any window within 15 feet, and not less than 8 feet above the roof, if the roof is used for drying clothes or as a roof garden.

SEC. 443. The drain pipe shall be supplied with a "Y" branch fitted with a brass clean-out or with an iron stopper, if required, on the direct run, at or near the point where the drain leaves the building. Changes in direction shall be made with curved pipes, and all connections with horizontal or vertical pipes shall be made with "Y" branches. Saddle hubs shall not be used.

SEC. 444. All high-pressure steam boilers shall be connected with a blow-off tank of a capacity not less than 30 per cent of the largest boiler connected with such tank. The location of and the connection to said blow-off tank shall be subject to the approval of the Superintendent of Sewers.

¶All heating pipes and appliances must be in accord and conform with the rules of good practice and the plans or "lay-out" of all such work must be first submitted to and approved by the Building Department before proceeding with the work. The purpose of this approval and the inspection of the work by the Department are solely to secure such work

as will in no way imperil the safety of the building, and in no event is the Department concerned as to whether the heating or lighting of the building is sufficient.

¶No steam exhaust or steam drip, unless it be provided with a cooling tank of a capacity approved by the Superintendent of Sewers, or unless it be connected with the blow-off tank, shall connect with any drain leading to the sewer. Every blow-off tank shall be supplied with a vapor pipe not less than 2 inches in diameter, which shall be carried above the roof and above the highest windows of the building.

SEC. 445. Every building from which grease may be discharged in such quantity as to clog or injure the sewer, shall have a special grease trap.

¶Every building in which gasoline, naphtha, or other inflammable compounds are used for business purposes, shall be provided with a special trap, so designed as to prevent the passage of such material into the sewer and ventilated with a separate pipe rising to a point 4 feet above the roof. ¶The waste pipe of every wash-stand for vehicles shall be provided with a sand trap of sufficient capacity.

SEC. 446. The waste pipe from the sink of every hotel, eating house, restaurant, or other public cooking establishment, shall be connected to a grease trap of sufficient size, easily accessible to open and clean, placed as near as practicable to the fixture that it serves.

SEC. 447. Rain-water leaders which open near windows or for verandas or lower stories of buildings shall be trapped.

SEC. 448. Rain-water leaders within any buildings shall not be connected with any waste or soil pipe except below the lowest fixture and on a full "Y."

SEC. 449. Wherever a surface drain is installed in a cellar or basement, it shall be provided with a deep seal trap and back water valve. Section 404 covers the drainage of roofs, protection of sidewalks, etc.

SEC. 450. In no case shall it be allowable for the drip from roofs or buildings to flow or be conducted upon public sidewalks.

SEC. 451. When special fixtures or traps are planned that do not conform to the provisions of this Code, the Building Department may at its discretion, grant such privilege as it may deem proper.

SEC. 452. The installation of all gas piping shall be subject to the approval of the Building Department.

¶All gas pipes shall be inspected and tested under the direction of the Building Department before the floors are laid.

SEC. 453. All gas brackets shall be placed at least 2½ feet below any ceiling or woodwork, unless the same is properly protected by a shield; in which case the distance shall be not less than 18 inches.

¶No swinging or folding gas bracket shall be placed against or near any stud partition or woodwork, and all swinging gas brackets shall be provided with stops to prevent them from swinging against the woodwork.

¶No gas bracket on any lath and plaster partition or woodwork shall be less than 12 inches in length measuring from the burner to the plaster surface or woodwork.

¶Gaslights placed near any combustible material shall be guarded by globes and wire cages.

SEC. 454. No electrical wiring or installation of electrical apparatus or appliances for furnishing light, heat, or power electrically shall be introduced into or placed in any building or structure in the City except in compliance with the rules and regulations of the National Board of Fire Underwriters, known as the "National Electrical Code," and the said rules and regulations are hereby made a part of the requirements of this Code. The installation of all such electrical work shall be subject to the approval of the Building Department.

CHAPTER XXI

HOISTWAYS, ELEVATORS, AND WELL-HOLES

SEC. 455. Every hoistway, hatchway, stairway, or well-hole in every building shall hereafter be securely guarded by means of proper gates, railings, or guards or other inclosures which may be approved by the Building Department. Such guards or railings shall not be less than 3 feet in height nor the lower rail more than 1 foot above the floor, and shall be so constructed as to effectually prevent persons from falling into such hoistways, hatchways, stairways, or well-holes. The owners, lessees, or occupants of any building in the City, in which hatchways or well-holes exist, or shall hereafter be constructed, shall cause the same to be effectually barred or inclosed, for the prevention of accidents therefrom.

SEC. 456. In every building hereafter erected or altered to be used for manufacturing or mercantile purposes, in which there shall be hoistways, elevators, or well-holes, not inclosed in walls, constructed of brick or other fireproof material and provided with fire doors, the openings thereof through and upon each floor of said buildings shall be provided with approved automatically closing, metal-clad hatch doors, for every such hoistway, elevator, or well-hole. Outside windows or openings into every elevator shaft or hoistway shall have such sign or device to indicate the existence of said shaft or hoistway as shall be approved by the Building Department.

SEC. 457. Elevator shafts in all mercantile and manufacturing buildings exceeding three stories in height, hereafter built or altered, shall be inclosed with walls or partitions of approved fireproof material, and have automatically closing, metal-clad doors at all openings thereto.

SEC. 458. In all buildings hereafter erected or altered, wherever elevators are placed in the well-holes of or adjacent to stairways, such elevators and stairways shall be inclosed with partitions of approved fireproof materials.

SEC. 459. There shall be placed below the machinery and sheaves at the top of every elevator shaft, hereafter constructed or altered, a substantial grating or screen of iron, so constructed as to prevent persons or objects from falling into such shafts, and sufficiently open to permit flames and smoke to pass through to the skylight or windows. If such shaft shall be floored over with a solid flooring, such flooring shall not cover more than one-half of the area of such shaft and at least one-half of the area of such shaft shall be covered with an approved open grating.

SEC. 460. In all buildings hereafter erected or altered, the roof immediately over hoistway, elevator, stair, open shaft, or well-hole, shall be provided with a skylight containing not less than 20 square feet of glass; said glass shall be set in metal sashes or frames, in lights of not less than 200 square inches each, and shall not exceed $\frac{1}{8}$ inch in thickness. There shall be suspended immediately below this glass a strong wire netting. Provided, that if in the sides of an elevator pent house, or at the top of any such shaft or well-hole, there be windows having 35 square feet of glass of the thickness herein specified for skylights, then the Building Department may, at its discretion, permit the skylights above described to be omitted.

CHAPTER XXII

STAIRWAYS AND DOORS

SEC. 461. All non-fireproof buildings, in which, above the first floor, there are to be, or in which provision is made for occupancy by, fifty to one hundred or more persons employed, engaged, transient, or guests therein, there shall be at least two stairways and halls, each not less than 3½ feet wide.

¶The width of the stairs shall be increased 6 inches for each increment of fifty persons or part thereof over one hundred up to three hundred, or when a width of 5 feet is reached. If the number of persons so occupying such premises exceed six hundred, three stairways, each 5 feet in width shall be constructed.

¶In all cases, the stairs shall be located at as great a distance as practicable from each other and in cases where the persons so occupying such buildings are not all on one floor, the widths and number of stairways in the several stories shall be governed as above by the total number of persons who will at any time be on any floor. All persons above any given story shall be counted in addition to the persons on that story.

SEC. 462. Irrespective of the number of persons occupying public buildings covering a lot area exceeding 5,000 square feet and not exceeding 7,500 square feet, there shall be provided at least two continuous lines of stairs, and every such building shall have at least one continuous line of stairs for each 5,000 square feet or part thereof of lot area covered, in excess of that required for 7,500 square feet of lot area.

¶When any such building covers an area of lot greater than 15,000 square feet, the number of stairs shall be increased proportionately. For fireproof buildings, one less flight of stairs than above called for shall be required in each case, unless the floor area exceeds 7,500 square feet in which case there shall not be less than two stairs.

SEC. 463. Every tenement or building, occupied by three or more families, shall have at least two flights of stairs, not less than 3 feet wide in the clear, one of which shall extend from the entrance floor to the top story, and every apartment shall be directly accessible from an entrance hall by means of at least one such flight of stairs.

¶If there are more than sixteen rooms above the second floor, exclusive of bath and toilet rooms, the width of the hallways and stairs shall be increased 6 inches for every additional sixteen rooms or fraction thereof, or until the width of 5 feet is reached.

SEC. 464. School buildings, if more than one story in height and having more than three rooms above the first story, shall have at least two separate and distinct stairways, as far removed from each other as practicable. School buildings or all buildings containing a general assembly room shall have stairs and fire-escapes proportioned as prescribed for Assembly Halls.

SEC. 465. Every hall seating three hundred persons and not more than six hundred persons shall have at least two separate and distinct stairways for ingress and egress, the same to be placed as far apart as possible.

¶Every hall seating more than six hundred persons and not more than twelve hundred persons shall have at least three separate and distinct stairways.

¶All stairs for ingress and egress leading to any assembly hall or halls, shall be at least 4 feet wide and provided with a hand-rail on each side.

¶In addition to the above described stairway, assembly halls shall be provided with fire-escapes as provided by law, provided that in assembly halls, having a greater seating capacity than seven hundred and fifty, the aggregate width of such emergency exits which shall be provided for each floor, balcony, and gallery of such building, shall be one-half of that provided for the main exits, and no emergency exit, door, or stairway shall be less than 3 feet in width.

SEC 466. The aggregate width of doors opening at the street level, for halls rented or used for public assemblies of any kind, for school houses, orphan asylums, insane asylums, or reformatories of any kind, shall be at least equal to the aggregate width of stairways; extra width shall be added to accommodate occupants of first floor and such doors shall not be locked during business hours, or while such buildings are occupied by large numbers of people, and all such doors shall open outwardly.

SEC. 467. Outside doors of all assembly halls, theaters, churches, schools, factories, and other buildings occupied by a large number of people shall be made to open outward.

CHAPTER XXIII

FIRE APPLIANCES, FIRE ESCAPES, AND FIREPROOF SHUTTERS AND DOORS

SEC. 468. In every existing building exceeding 55 and not over 100 feet in height, unless already provided with a 3-inch or larger standpipe and in all buildings hereafter erected exceeding 55 and not exceeding 100 feet in height, there shall be provided a vertical standpipe of not less than 4 inches in diameter.

¶In every existing building exceeding 100 feet in height, unless already provided with a 4-inch or larger standpipe; and in all buildings hereafter erected exceeding 100 feet in height, there shall be provided a vertical standpipe of not less than 6 inches in diameter.

¶These standpipes shall be of galvanized wrought iron or steel and, together with fittings and connections, shall be of such strength as to safely withstand at least 300 pounds water pressure to the square inch when installed and ready for service; also to stand such a test without leaking at joints, valves or fittings.

¶Standpipes shall be located within fireproof stairway inclosures where the latter are of such construction, and as near stairways as possible where they are not so inclosed.

¶In buildings exceeding 100 feet deep fronting on two or more streets, there shall be a standpipe at each end of the building, and in large area buildings there shall be one standpipe at each stairway or within each stairway inclosure.

¶Where more than one standpipe is required in a building they shall be connected at their bases by pipes of size equal to that of the largest standpipes, so that water from any source will supply all the standpipes.

¶Standpipes shall extend from the cellar to and through the roof, with a hose connection located from 4 to 6 feet above the floor level and fitted with approved straightway composition gate valves in each story, including cellar, and a hose connection provided above the roof, with a controlling valve located in the standpipe under the roof and so arranged as to be operated both from above and below the roof. A suitable ¾-inch drain pipe and valve shall be provided under the roof for each roof connection.

SEC. 469. Hose sufficient to reach to all parts of the floor shall be attached to each outlet in the building, and hose for the roof-hydrant may be placed on a rack in the top floor near the scuttle leading to the roof. Hose shall be 2½ or 2¾ inches in diameter, shall be in 50-foot lengths and provided with standard couplings at each end, all couplings to be of the same hose thread as that in use by the local Fire Department.

¶The hose shall be approved linen, cotton, rubber lined, or rubber, made under specifications recommended by the National Board of Fire Underwriters.

¶Each line of hose shall be provided with washers at both ends and be fitted with a play pipe or nozzle of Underwriter pattern, having handles at the base and a discharge outlet not less than ¾ inch in diameter. One spanner shall be located at each hose connection throughout the building.

SEC. 470. All standpipes shall be provided with Siamese steamer connections located on the outside of the building about 1 foot above the curb level, and where a building fronts on two or more streets, a connection shall be provided on each street front. The inlet pipe from the steamer connection to the standpipe shall not be less than the diameter of the largest standpipe. The thread on the Siamese connection shall be uniform with that used by the local Fire Department. Siamese steamer connections shall be provided with check valves in the "Y" and substantial caps provided to protect the thread on the connection. The steamer connection fitting should be adjusted, looking down at an angle of forty-five degrees. A suitable iron plate with raised letters shall be secured to the wall near the steamer connection reading: "To Standpipes."

¶In each connecting pipe just inside of the building, in a horizontal section, shall be placed a straightway check valve, but not a gate valve. A drip pipe with valve to same, shall be placed between said check valve and steamer connection to properly drain this section, in order to prevent freezing.

¶In addition to the provision made for steamer connections to standpipes, the water supply may be drawn from the City water system where pressure is sufficient; or from automatic fire pump of 500 gallons or more capacity per minute; or from elevated tank or steel pressure tank of not less than 5,000 gallons capacity.

¶In all buildings coming under these regulations as to height, which are occupied for living or sleeping purposes, such as hotels, lodging houses, hospitals and asylums, the standpipe system must have at least one of the approved automatic supplies before described.

SEC. 471. Where a standpipe is connected to a tank there shall be a straightway check valve in a horizontal section of pipe between the first hose

outlet in connecting pipe and tank, and said tank must be filled by a separate pipe, and not through the standpipe; and where the water in such tank is also used for house supply, the house supply pipe shall extend from the bottom of the tank to such a height as will reserve not less than 3,500 gallons of water for fire purposes.

¶Where pumps which constitute a supply to standpipes are located in the lowest story of a building, they shall be placed not less than 2 feet above the floor level, and boilers upon which pumps depend for steam shall be arranged so that flooding of fires under the same will be impossible.

¶In every building exceeding 100 feet in height, at least one passenger elevator shall be kept in readiness for immediate use by the Fire Department during all hours of the night and day, including holidays and Sundays.

SEC. 472. All existing buildings, and those hereafter erected exceeding 100 feet in height shall be provided with auxiliary fire apparatus and appliances, such as wrenches, spanners, fire extinguishers, hooks, axes, pails, and such things as may be required by the Commissioner of the Fire Department; all of said apparatus to conform in design to that in use by the local Fire Department.

SEC. 473. Buildings of large area, which are occupied for mercantile or manufacturing purposes, when located within a congested district, forming, in the opinion of the Building Department or Chief of Fire Department, "Conflagration Breeders," shall be protected throughout the entire building with automatic sprinklers.

¶The pipe sizes and spacing of heads for said sprinkler system shall conform to the schedule and rules recommended by the National Board of Fire Underwriters which are hereby made a part of the requirement of this Code.

¶Said sprinkler pipes shall be connected with a pipe of not less than 4 inches in diameter leading to the outside of the building and there provided with an approved Siamese steamer connection, the latter to be installed under requirements set forth in this Section, and to be under the control and for the use of the Fire Department.

¶A suitable iron plate with raised letters shall be securely attached to the wall near said steamer connection, reading "Cellar Sprinklers," where sprinklers are installed in cellars only, and reading "Automatic Sprinklers," where the entire building is so protected.

SEC. 474. Every apartment house, tenement house, or dwelling house occupied by or built to be occupied by three or more families,

¶And every building already erected, or that may hereafter be erected,

more than three stories in height, occupied and used as a hotel, apartment hotel, or lodging house, and every boarding house having more than fifteen sleeping rooms above the basement story, and every factory, mill, manufactory, or workshop, hospital, asylum, or institution for the care or treatment of individuals,

¶And every building three stories and over in height used or occupied as a store or workroom,

¶And every building in whole or in part occupied or used as a school or place of instruction or assembly,

¶And every office building four stories or more in height,

¶Shall be provided with such good and sufficient fire-escapes, stairways, or other means of egress in case of fire as shall be directed by the Building Department.

SEC. 475. The owner or owners of any building upon which a fire-escape is erected shall keep the same in good repair and properly painted.

¶Fire-escapes on the outside of buildings shall consist of open iron balconies and stairways.

¶Fire-escapes may project into the public highway above the first story to a distance not greater than 4 feet beyond the building line.

¶The stairways shall be placed at an angle of not more than 60 degrees, with steps not less than 6 inches in width and 20 inches in length, and with a rise of not more than 9 inches.

¶The balcony on the top floor shall be provided with a goose-neck ladder or other contrivance leading from said balcony to and above the roof.

SEC. 476. The balconies shall be not less than 3 feet in width and placed where directed by the Building Department at each story above the ground.

¶They shall be below, and not more than 1 foot below, the window sills, and they shall extend in front of, and not less than 9 inches beyond, each window.

¶There shall be a landing not less than 24 inches square at the head and foot of each stairway.

¶The stairway opening on each platform shall be of a size sufficient to provide clear headway.

SEC. 477. The floors of balconies shall be of wrought-iron or steel slats not less than 1½ inches by ⅜ inch, placed not more than 1¼ inches apart and well secured and riveted to iron battens 1½ inches by ⅜ inch, not over 3 feet apart, and riveted at the intersections. The openings for stairways

in all balconies shall be not less than 21 inches wide and 36 inches long, and such openings shall have no covers of any kind.

¶The platforms or balconies shall be constructed and erected to safely sustain in all their parts a safe load, at a ratio of 4 to 1, of not less than 80 pounds per square foot of surface.

SEC. 478. The outside top rail shall extend around the entire length of the platform and in all cases shall go through the wall at each end and be properly secured by nuts and 4-inch square washers at least $\frac{3}{8}$ inch thick, and no top rail shall be connected at angles by cast iron. The top rail of balconies shall be $1\frac{3}{4}$ inches by $\frac{1}{2}$ inch of wrought iron, or $1\frac{1}{2}$-inch angle iron $\frac{1}{4}$ inch thick. The bottom rails shall be $1\frac{1}{2}$ inches by $\frac{3}{8}$-inch wrought iron or steel, or $1\frac{1}{2}$-inch angle iron $\frac{1}{4}$ inch thick, well leaded into the wall. The standards or filling-in bars shall be not less than $\frac{1}{2}$ inch round or square wrought iron or steel, well riveted to the top and bottom rails and platform frame. Such standards or filling-in bars shall be securely braced by outside brackets at suitable intervals and shall be placed not more than 6 inches from centers; the height of railings shall in no case be less than $2\frac{3}{4}$ feet.

SEC. 479. The stairways shall be constructed and erected to fully sustain in all their parts a safe load at a ratio of 4 to 1 of not less than 100 pounds per step, with the exception of the tread which must safely sustain at said ratio a load of 200 pounds. The treads shall be flat, open treads not less than 6 inches wide and with a rise of not more than 9 inches. The stairs shall be not less than 20 inches wide. The strings shall be not less than 3-inch channels of iron or steel or other shape equally strong and shall rest upon and be fastened to a bracket which shall be fastened through the wall as hereinafter provided. The strings shall be securely fastened to the balcony at the top, and the steps in all cases shall be double-riveted or bolted to the strings. The stairs shall have $\frac{3}{4}$-inch handrails of wrought iron, well braced.

SEC. 480. The brackets shall be not less than $\frac{1}{2}$ inch by $1\frac{3}{4}$-inches wrought iron placed edgewise, or $1\frac{3}{4}$-inch angle iron $\frac{1}{4}$ inch thick, well braced; they shall be not more than 4 feet apart, and shall be braced by means of not less than $\frac{3}{4}$-inch square wrought iron and shall extend two-thirds of the width of the respective balconies or brackets. The brackets shall go through the wall and be turned down 3 inches, or shall be properly secured by nuts and 4-inch square washers at least $\frac{3}{8}$ inch thick.

¶On new buildings the brackets shall be set as the walls are being built.

¶When brackets are put on buildings already erected the part going through

the wall shall be not less than 1 inch in diameter with screw nuts and washers not less than 5 inches square and ½ inch thick.

SEC. 481. A proper drop or balanced ladder shall be required from the lower balcony when the floor of such balcony is more than 14 feet above the sidewalk or ground.

SEC. 482. All the parts of such fire-escapes shall receive not less than two coats of paint, one in the shop and one after erection.

SEC. 483. No person shall at any time place any incumbrances of any kind whatsoever before or upon any fire-escape, balcony, or stairway.

¶It shall be the duty of every fireman and policeman who shall discover any fire-escape, balcony, or stairway of any fire-escape incumbered in any way, to forthwith report the same to the commanding officer of his company or precinct, and such commanding officer shall forthwith cause the occupant of the premises or apartment to which said fire-escape, balcony, or stairway is attached or for whose use the same is provided, to be notified, either verbally or in writing, to remove such incumbrances and keep the same clear.

¶If said notice shall not be complied with by the removal, forthwith, of such incumbrances, and by the keeping of said fire-escape, balcony, or stairway free from incumbrance, then it shall be the duty of said commanding officer to apply to the nearest police magistrate for a warrant for the arrest of the occupant or occupants of said premises or apartment of which the fire-escape forms a part, and the said parties shall be brought before the said magistrate and for a misdemeanor, and on conviction, the occupant or occupants of said premises or apartment shall be fined not more than ten dollars for each offense or may be imprisoned not to exceed ten days, or both, in the discretion of the court.

SEC. 484. In constructing all balcony fire-escapes the manufacturer thereof shall securely fasten thereto, in a conspicuous place, a cast-iron plate having suitable raised letters on the same, to read as follows:

NOTICE! *Any person placing any incumbrance on this balcony is liable to a penalty of ten dollars and imprisonment for ten days.*

SEC. 485. All buildings requiring fire-escapes shall have stationary iron ladders leading to the scuttle opening in the roof thereof, and all scuttles and ladders shall be kept so as to be ready for use at all times.

SEC. 486. If a bulkhead is used in place of a scuttle, it shall have stairs with sufficient guard or handrail leading to the roof.

¶In case the building shall be occupied by more than one family, the door

in the bulkhead or scuttle shall at no time be locked, but may be fastened on the inside by movable bolts or hooks.

SEC. 487. The foregoing describes what will be exacted and deemed a suitable means of escape from buildings—a "standard" fire-escape—but is not planned as a bar to ingenuity in devising as effective, or perhaps better, escapes. It is simply a basis upon which all others shall be judged. If the owner of a building desires to install a circular chute-escape or a system of railings and footwalks at all windows and leading to a ladder affixed somewhere that fire cannot assail it, or if portable fire-escapes of an approved and easily handled pattern be proposed in sufficient number—such as one for every four communicating rooms in an apartment or at least one per class in a school—then a full description and drawings of such escape system shall be submitted to the Building Department and the matter will be passed upon by the Advisory Board, and if permitted, the party will be directed by the Building Department as to the number and the strength of such escapes as may be installed in lieu of the standard here described.

¶A rope attached to a window or merely available in a room, particularly in hotels, will not be deemed a sufficient fire-escape under any circumstances, though the provision of such ropes, etc., over and above what the Building Department may approve as sufficient fire-escape, will of course not be barred.

SEC. 488. This same provision is to obtain in regard to all devices herein described. Such description is merely to establish the minimum of a standard requirement, but it is not calculated to bar what may be devised or has been devised that is equally effective. But where a radical departure is proposed from what is described it can only be done by the Advisory Board. The function of the Inspectors and Commissioners is administrative and not discretionary.

CHAPTER XXIV

MISCELLANEOUS

SEC. 489. The Building Department, whenever there are practical difficulties in the way of carrying out the strict letter of this Code, shall have power to vary or modify any of the provisions of this Code, or any rule or regulation of the said Code relating to the construction, alteration, or removal of any building or structure erected or to be erected within the City upon an application to it in writing by the owner or lessee of such building or structure, or his duly authorized agent, so that the spirit of this Code shall be observed and public safety secured and substantial justice done; but no such variation or modification shall be granted or allowed unless the particulars of each application and of the decision of the majority present at a meeting of the Advisory Board shall be entered upon the records.

¶And if the application is granted, a certificate therefor shall be issued be the Building Department.

SEC. 490. Whenever it is desired to use new materials or materials not specified in this Code, application therefor shall be made to the Building Department in writing, stating in detail the materials and the manner and the construction in which they are to be so used. The person or persons seeking to use such new materials shall give the said Department upon its request therefor, such information and tests in connection with the nature and use of such proposed new materials as the said Department may require.

SEC. 491. All matters and questions relating to building or building operations not specifically covered or provided for in this Code shall be decided by and left to the discretion of the Building Department—meaning the passing upon such matter by the Advisory Board—and its decision shall be as final and binding as if contained in this Code.

SEC. 492. Whenever any person, persons, firm, or corporation, considers himself, or themselves, aggrieved by any ruling, decision, or order of an inspector or the Commissioner of the Building Department, relative to any matter concerning buildings, or building operations in the City, or any other matter over which the Building Department has authority, he or they shall

have the right to appeal to the Department as a whole, the Advisory Board, provided the party so appealing executes with a responsible surety a proper bond conditional to pay all expenses incident to such appeal, if the decision be against him or them. And in the event of that decision not being satisfactory to the protestor, then his appeal must be to the courts, but the decision and ruling of the Department shall stand and must be obeyed, until it be set aside by the ruling of the courts.

¶The decision of the said Advisory Board of the Department on any matter brought before it shall be final as far as the city is concerned.

SEC. 493. Every person, persons, firm, or corporation, violating any of the provisions of this Code, where the penalty is not otherwise prescribed, shall be fined not more than *One Hundred Dollars* upon conviction for each violation.

SEC. 494. All ordinances or parts of ordinances inconsistent herewith are hereby repealed and, furthermore, this ordinance is made retroactive insofar as public or semi-public buildings—and the ventilating, lighting, access and exit thereof and therefrom—where a large number of people may be housed or assembled, or where present structures of any nature whatsoever, or where the plumbing, heating, lighting, elevators, or details thereof, may be deemed dangerous to the life or to the health of the community, all in accord with the sections of this Code that relate to occupancy of build, ings, their nature, and to the powers of the Department in dealing with present and future buildings.

REVIEW QUESTIONS

REVIEW QUESTIONS

ON THE SUBJECT OF

ESTIMATING

PART I

1. (a) What will a walk of bluestone flagging 4 ft. wide and 19 ft. long cost, complete? (b) Give cost of limestone coping for an 18-inch wall on one side of the path.

2. (a) About how many square yards of surface will four pounds of paint cover in two coats? (b) How much will it cost to paint a brick wall 8 ft. high and 15 ft. long with three coats of paint?

3. (a) How many feet B. M. in a 4-in.×10-in. stick 22 ft. long? (b) How much lumber will it take to stud up a wall 12 ft. long and 9 ft. high with two windows in it?

4. Give an analysis of one cubic yard of concrete.

5. What percentage of the cost of a building should be allowed for heating by furnace? How much of this goes to the labor?

6. What will a square of slating cost?

7. Analyze the cost of a square of flooring.

8. (a) What will be the cost of a plain copper roof for a store 30 ft.×40 ft.? (b) What will be the cost of a tin roof?

9. How many cubic feet of wall will a thousand bricks lay?

10. Give an analysis of the cost of 100 square yards of 2-coat plastering.

11. What special data besides plans and specifications are necessary to figure a job for a contract?

12. How many square feet will 1000 shingles lay at 5 in. to the weather?

13. What will be the approximate cost of a house 20 ft.×30 ft. with an 8 ft. cellar and a half-pitch gable roof, at 12 cents per cubic foot?

14. How large a furnace pipe must be run to a room 15 ft. ×20 ft. and 10 ft. high, and what will be the size of register?

15. Give a rule for finding the number of studs in a front if set 16 in. on centers. If set 12 in. on centers.

16. What will be the cost of an ordinary flight of stairs of 17 risers for a $3,000 house? How much should be allowed for the cellar stairs of 14 risers?

17. How much studding can two men set in one day? How much boarding? Shingles? Diagonal boarding?

18. (a) How many square yards of 2-coat plastering can a mason and helper put on in one day? (b) What will it cost?

19. (a) What will the newel of an ordinary staircase cost? (b) How much will the balusters of first run cost at two to a tread if the run is 8 risers high?

20. (a) How many bricks will be required to build a wall 10 ft. high, 30 ft. long, and 1 ft. thick. (b) What will it cost in 1 to 3 lime mortar?

21. What will it cost to put on 1,000 laths?

22. In making repairs a man required the services of a carpenter for 5 hours, a plumber and helper 2 days, and an electrician for a day and a half, what was his bill for labor?

23. What will it cost to dig out a cellar 18 ft.×30 ft.; 4 ft. below grade at one end and 6 ft. the other?

24. (a) At a base price of $2.45 per cwt. what will three cwt. of 6-penny box nails cost? (b) What will 1 cwt. of 4-penny slating nails cost?

25. (a) What per cent of the cost of a house will usually go to the plumbing? (b) What portion of this will represent the labor?

26. (a) What is the relative cost of marble as compared with limestone? (b) Of sandstone as compared with limestone?

27. (a) What is the usual cost of molded finish in white wood or cypress? (b) What will the casings for both sides of a door 3 ft.×7 ft. cost, using a 5-inch casing with corner blocks?

28. (a) About how many cubic feet will one square foot of direct steam radiation heat, in the first story of a dwelling? (b) Direct hot water radiation?

29. What will be the area of a pyramidal roof 20 ft. square at the base and 15 ft. on the rafter line?

REVIEW QUESTIONS

ON THE SUBJECT OF

ESTIMATING

PART II

1. What is the usual method of making up an accurate estimate of the cost of a building?

2. What will it cost to plaster a hall 45 ft. by 70 ft.. and 20 ft. high, with 8 windows 5 ft. by 9 ft., and two doors 8 ft. by 10 ft.?

3. Give analysis of cost of a square of hard pine upper floor, using stock costing $60 per M.

4. What will be the cost of excavating and building the rough stone wall of a leaching cesspool, to finish 7 ft. 0 in. in diameter inside, and 8 ft. 0 in. deep, below ground, laid up of dry stone 1 ft. 0 in. thick, at $3.50 per perch, stone wall to be carried 5 ft. 0 in. high fron bottom; excavation to be 1 ft. larger than cesspool all around, at 50 cents per cu. yd.?

5. (*a*) How many perches are there in the following amount of masonry?

16 ft. 0 in. × 6 ft. 7 in. × 1 ft. 8 in.
5 ft. 4 in. × 6 ft. 7 in. × 1 ft. 8 in.
10 ft. 8 in. × 6 ft. 7 in. × 1 ft. 8 in.

(*b*) How much will it cost at $4.25 per perch?

6. What will be the cost of concreting a cellar 30 ft. by 40 ft. at 60 cents per sq. yd.?

7. What will it cost to finish the floors of a parlor, 16 ft. by 18 ft. and a dining room 14 ft. by 17 ft., at 30 cents per yard?

8. Why should a cellar be excavated larger than the outside of the foundation wall?

9. What will be the cost of 16 ft. of galvanized smokepipe at \$0.09 per lb., pipe to weigh 2½ lb. per foot?

10. What will it cost to excavate a cellar 30 ft. by 40 ft., and 5 ft. deep, at 50 cents per cu. yd.?

11. What will be the cost of a chimney with two 8 by 12-inch flues, 35 ft. high, brickwork costing \$20 per M laid?

12. What will be the cost of a stucco cornice for a room 12 ft. by 16 ft., at 25 cents per foot?

13. If furnace layout consists of five 7-in. pipes, three 9-in. pipes, and two 14-in. pipes, what should be the area of the cold-air box?

14. Give analysis of cost of a square of clapboarding, using clapboards at \$50 per M.

15. (*a*) Show by analysis the approximate cost and method of figuring a piazza cornice.

(*b*) A rear door and frame.

16. Give analysis and approximate cost of a window complete, without hardware; sash 3 ft. 6 in. by 5 ft. 0 in.

17. Give analysis and approximate price, per square, of a shingled roof, using matched boards on 2 ft. 7 in. rafters.

18. (*a*) How many bricks, per foot of height, will be required in a chimney of two 8 by 12-in. flues, with 4-in. walls and withes?

(*b*) In a chimney with three 8 by 12-in. flues?

(*c*) In an ashpit, 12 in. by 3 ft. 8 in. inside measurement, with 4-inch back and front walls and 8-in. end walls? Make sketch plan of each, showing bricks.

19. (*a*) Give a reasonable cost for hardware of seven inside doors put on.

(*b*) Of fifteen windows with sash-fasts and lifts.

20. What is a fair price for building lattice under a piazza 9 ft. 0 in. by 36 ft. 0 in., showing 1 ft. 6 in. at one end and 3 ft. 6 in. at the other end, with a 6-foot flight of steps taken out at the center?

REVIEW QUESTIONS

ON THE SUBJECT OF

CONTRACTS AND SPECIFICATIONS

1. Describe generally the *province* of the specification.

2. Describe generally the *characteristics* of the specification.

3. Describe generally the *limits* of the specification.

4. State the nature of the relationship the specification should endeavor to establish between the owner, builder, and architect, and how such relationships are to be encouraged and maintained.

5. How do specifications affect and influence the cost of completed work?

6. Describe the position in the transaction of (a) The Owner, (b) The Contractor, (c) The Specification Writer.

7. Make an outline of a contemplated work other than that stated in the text (preferably of some simple structure familiar to the student, as the home he lives in, or a neighboring store or building to which he has access) hereafter called the "Student's Scheme".

8. State some of the points to be studied in connection therewith before the specification is begun.

9. Why should a specification writer make a special study of materials?

10. Describe the province of sand in mortar and how you would select a sand for use.

11. Describe some experiment, other than those given in the text, which would throw light on the value of a material used in the "Student's Scheme".

12. Give a list of trade catalogues you have collected.

13. Give a list of subjects which in the "Student's Scheme" should be included in the "General Conditions".

14. Give a list of masonry materials required in the "Student's Scheme".

15. Write a 400 word specification as required in Note 1, page 33.

16. Give a list of carpenters' materials required in the "Student's Scheme".

17. Write a 400 word specification as required in Note 2, page 38.

18. Write a 400 word specification as required in Note 3, page 39.

19. Give a list of fixtures required in the plumbing work of the "Student's Scheme".

20. Write a 400 word specification as required in Note 4, page 43.

21. Describe a system of heating a building ("Student's Scheme") other than that herein required.

22. Write a 400 word specification as required in Note 5, page 44.

23. State the points which the "Formal Contract" should cover.

REVIEW QUESTIONS

ON THE SUBJECT OF

THE ARCHITECT IN HIS LEGAL RELATIONS

---

1. Supposing an architect and his client have bargained for the making of plans alone. The owner then writes to the architect offering to pay $250 for plans such as have been discussed. The architect writes a note saying, "I will accept your offer and will make the plans the mentioned for $250". This note the architect gives to his office boy, who, however, never delivers it. The architect, in ignorance of the boy's neglect, makes the plans, and offers them to his client four months later. The owner refuses to take them or pay for them. Was there any contract on which the architect can recover?

2. An architectural student, twenty years of age, says to *A*: "When I begin to practice my profession I will make plans for the house you propose to build, and will superintend the construction of it. I will charge you $1,000 for the entire work". Eighteen months later, he begins to practice, and *A* asks him to carry out his agreement, which he refuses to do. Has *A* any remedy?

3. Supposing it is orally agreed bewteen *A*, a real estate speculator, and *B*, an architect, that *B* shall give his entire time to *A* in designing and superintending the construction of houses for the period of three years for a salary of $2,000 a year. After 6 months of work by *B*, *A* refuses to continue the contract or to pay for the work already done. Has *A* any legal remedy, and if so, to what extent?

4. *A*, the owner of a house, orally agrees with *B*, an architect, that on a day two months distant, *B* shall deliver to *A* certain plans for alteration of *A*'s house, that *A* shall thereupon pay $500 for the plans; and that thereafter *B* shall superintend the alterations, which are to be finished within ten months from the date of making the contract, and shall be paid at a fixed rate for his time.

On the date agreed, *B*, although he has not finished the plans, demands the payment of the agreed sum. This is refused, and he brings suit for it. Can he recover?

5. *A*, the agent for a certain building material, comes to *B*, a contractor who is building a block on his own account, and asks *B* to purchase some of his building material for the block, representing that it is fireproof, and will not change color with exposure. *B*, believing *A*'s representations, makes a contract for a certain amount of the material. Before the material is delivered, *B* makes experiments and finds that the material is not fireproof, and that it does change color with exposure. What course should he pursue?

6. *A* and *B* make an agreement for the construction of a building, the contract price being agreed upon as $5,000. The contract is reduced to writing, and after signing it *B* finds that the price was inserted as $5,500. He asks *A* to agree to change the amount to conform to their understanding, and *B* refuses. What course snould *B* pursue?

7. An architect is called upon to superintend the construction of a building, which is already in course of erection. He finds that *X* has orally agreed to guarantee the fulfillment of the contract by the builder, and to be responsible to *A*, the owner, for any default in the performance of the builder's contract. The architect is also asked to make extensive changes in the plans, agreed to by the builder. What course might the architect recommend in order to enable *A* to hold *X* responsible as surety?

8. If an architect is offered a rebate for his own benefit on the selling price of building material to be used in a client's house, what should he do?

9. A directs his architect to find out the best terms upon which tiles can be bought. The architect secures informal bids, and says to the lowest bidder that he represents *A* in the matter, and that as agent of *A* he will take a certain quantity of the tiles at the price named. *A* refuses to accept the tiles. Has the seller any remedy (a) against *A*? (b) against the architect?

GENERAL INDEX

GENERAL INDEX

In this Index the *Volume number* appears in Roman numerals—thus, I, II, III, IV, etc., and the *Page number* in Arabic numerals—thus, 1, 2, 3, 4, etc. For example, Volume IV, Page 327, is written, IV, 327.

The page numbers of this volume will be found at the bottom of the pages; the numbers at the top refer only to the section.

	Vol.	Page
A		
Accurate method of estimating	V,	15
Adjustable dies	IV,	198
Adjustable tongs	IV,	200
Administration of building code	V,	307
Agreement between contractor and owner	V,	278, 288
Air		
analysis of	IV,	18
force for moving	IV,	21
required for ventilation	IV,	19
Air distribution	IV,	22
Air leakage, heat loss by	IV,	24
Air test of drain	IV,	333
Air-valves	IV,	68, 119, 195
Air velocity, measurements of	IV,	21
Air-venting	IV,	115
Aisles in auditoriums	V,	382, 390
Alternating current	III,	239
Alternating-current motors, wiring for	III,	270
Aluminum paints	I,	424
Angle valves	IV,	68
Angles	II,	110, 114
Appendix to "Legal Relations"	V,	277–305
Approximate delivery	IV,	276
factors influencing rate of flow	IV,	276
Approximate measurements	II,	275
Approximate methods of estimating	V,	14
Arbitration	V,	303
Arc	III,	237
Arc lamps on constant-potential circuits	III,	322
Arch bricks	III,	140
Arches	III,	153, 168
Architect	V,	123, 141, 182, 203, 247, 266, 292, 304
compensation	V,	268, 304
competitive designs	V,	266
duties	V,	123, 141, 182, 203, 247, 255, 292
liability of	V,	264
position under building contract	V,	249
practical suggestions	V,	269
professional practice	V,	304
Architectural drawing	II,	213–332
definitions	II,	224
exhibition drawings	II,	270
importance of axes	II,	225
instruments and materials	II,	213
line drawing	II,	221
measured work	II,	273
practical problems in design	II,	277
preliminary studies	II,	267
rendering in wash	II,	243
sketching	II,	270
Architraves	III,	103
Arithmetical principles	V,	17
Armature end ring	II,	50
Armature head	II,	48
Armature punchings	II,	49
Armored cable	III,	347
Armored circuits, insulation for	III,	388

Note.—For page numbers see foot of pages.

	Vol.	Page
Artificial water line	IV,	170
Asbestos shingles	III,	179
Ash pits	IV,	156
Ash receivers	III,	100
Ashlar masonry	III,	163
Assembled cone gears	II,	41
Atlas trap	IV,	224
Atmosphere, composition of	IV,	17
Attic partitions	I,	156
Attic plans	II, 301,	307
Auditoriums, requirements for lighting	III,	369
Automatic return-pumps	IV,	140
Automatic sprinklers	V, 393,	416
Autostarter	III,	273
Awning blind hinge	IV,	409
Axes in architectural drawing	II,	225
B		
Baby baths	IV,	233
Back clutch pinion	II,	26
Back plastering	I, 389; III,	46
Back-pressure valve	IV,	138
Back tool post	II,	38
Backfilling	V,	184
Bag trap	IV,	222
Balconies	I,	174
Balloon frame	I,	82
Bankruptcy	V,	245
Baseboard	I,	258
Basement plan	II,	296
Basements, drainage of	IV,	325
Bath fixtures	IV,	227
Bathroom	II,	284
Bathtubs	III, 80; IV,	227
Battened splice	I,	72
Battered frames	I,	159
Beam ceilings	III,	103
Beams	I,	169
Bearing walls	III,	149
Bell-ringing transformers	III,	405
Belt courses	I,	212
Bending moment on columns	V,	362
Bevel gears for rolls on sheet bar and slab mill steam flying shear table	II,	52
Bids, contractors'	V,	199
Bill of quantities	V,	127
Binder arm for rope take-up	II,	55
Blind adjuster	IV,	408
Blind hinges	IV,	407
Block stone walls	III,	136
Blow-off tank	IV,	78
Blueprint reading	II,	11–64
analysis of typical blueprint	II,	24
general directions for	II,	13
introduction	II,	11
Blueprints analyzed	II,	24
Bluestone	V,	28
Board measure	V,	34
Boiler connections	II, 77,	156
Boiler fittings	IV,	158
Boiler horsepower	IV,	46
Boiler trimmings	IV,	158
Boilers	III, 95; IV, 152, 158, 365, 388; V,	336
capacity of	IV,	158
collapsing of	IV,	388
selection of	IV,	153
Bolts	III, 115; IV,	424
Bond of suretyship, notes on	V,	279
Bonding	III,	146
Bonds in relation to contracts	V,	204
Border lights	III,	366
Boundary limits	V,	314
Bow pen and pencil	II,	79
Bower-Barff process	IV,	434
Bowled floors	I,	165
Braced frame	I,	82
Branch coil	IV,	55
Branch soil pipe	IV,	335
Branches, size of	IV,	128
Brass pipes	III,	67
Breach of contract	V,	236
Brick	III, 140; V, 185,	316
Brick-and-frame buildings	V,	345
Brickwork	III, 140; V, 29, 77, 145,	187
cost	V,	30
mortar	V,	30
quantities	V,	29
Bridging	I, 98, 116; III,	36
British thermal unit	IV,	23
Broad-leaved trees	I,	34

Note.—For page numbers see foot of pages.

	Vol.	Page
Bronze paints	I,	424
Brown coat of plaster	I,	383
Brushes	I, 408; II,	262
Building, laying out	I,	51
Building code	V, 307–	422
administration and supervision	V,	307
boilers, ovens, and heating apparatus	V,	336
calculation of stresses	V,	322
chimneys, flues, and fireplaces	V,	342
concrete building blocks	V,	369
excavations	V,	324
factors of safety	V,	321
fire appliance and escapes	V,	414
fire limits	V,	314
fireproof construction	V, 349,	414
foundations and footings	V,	325
frame and brick-and-frame buildings	V,	345
in general	V,	397
hoistways, elevators, and well-holes	V,	410
mill construction	V,	348
miscellaneous	V,	421
plans, fees, penalties, and licenses	V,	311
plumbing, heating, and lighting	V,	401
public buildings, theaters	V,	382
quality of materials	V,	315
reinforced concrete construction	V,	358
reinforced terra cotta hollow tile	V,	368
stairways and doors	V,	412
steel and wrought-iron construction	V,	374
stove and smoke pipes	V,	340
terra cotta building blocks	V,	372
walls, piers, and partitions	V,	328
Building department, personnel and powers of	V,	307
Building paper	I,	206
Building superintendence	III, 11–	232
cellar work and foundations	III,	23
Building superintendence (continued)		
city buildings	III,	131
electric wiring	III,	52
frame construction	III,	11
framing	III, 34,	48
heating	III,	87
inside finish	III,	101
lathing and plastering	III,	59
mason work	III,	44
materials	III, 15,	23
outside finish	III,	53
plumbing	III,	66
supervision	III, 11,	14
ventilation and gas pipes	III,	50
Bullnose tread	I,	293
Butt hinges	IV, 399,	401
Butt joint	I,	58

C

Cabinets	III,	401
Cables	III,	251
Canopy insulators	III,	315
Cap and sole	I,	98
Car wiring	III,	372
Carbonic acid gas	IV,	17
Carpenter work	V, 83, 110, 147,	189
analysis of	V,	110
exterior finish	V,	149
framing	V, 147,	190
interior finish	V,	151
materials required	V,	189
Carpenters' tools	I,	42
Carpentry	I, 11–263; V,	34
exterior and interior finish	I,	203
floors	I,	103
framing	I,	57
roof	I,	121
special framing	I,	159
timber in natural state	I,	13
tools used in	I,	42
Cartridge fuses	III,	393
Casement sash and frames	I,	239
Casings of stacks	IV, 87,	125
Cast-iron boilers	IV,	151
Cast-iron radiators	IV,	53
Cast stone	III,	166

Note.—For page numbers see foot of pages.

	Vol.	Page
Catalogues, use of in estimating	IV, 441; V,	12
Catch basins	IV,	325
Cellar	II,	284
Cellar columns	V,	33
Cellar drainer, use of	IV,	327
Cellar-window hardware	IV,	431
Cellar work	III,	23
concrete	III,	33
construction of	III,	31
description of good and poor	III,	28
drains and cesspools	III,	23
foundations	III,	23
underpinning	III,	33
walls	III,	27
Cement	III, 143; V, 170, 184, 316,	364
Center arm head	II,	39
Center rest assembly	II,	35
Center rest base	II,	34
Center rest top	II,	33
Certificates, architect's	V, 249,	297
Cesspools	III, 24; IV, 317; V,	77
Check valve	II,	58
Checks	I,	23
Chemical fire extinguishers	V,	394
Chimney flues	IV,	38
Chimney furring	III,	49
Chimneys	III, 44; V, 32,	342
Chisels	IV,	202
Church spire	I,	190
Circles	II,	113
Circuit breakers	III, 252, 305,	399
Circuit system	IV,	128
Circuit venting	IV,	342
Circulation, systems of	IV,	108
Circulation coils	IV,	55
City buildings	III,	131
City regulations, relation to specifications	V,	164
City work, specifications for	V,	163
cement	V,	170
electric wiring	V,	177
lumber	V,	174
preliminary studies	V,	163
roofing material	V,	175
sand	V,	166
City work, specifications for (continued)		
studies in materials	V,	165
Clapboarding	I, 208; III,	58
Close-grain woods	I,	418
Closet tanks	IV,	241
Coal chute	III,	57
Coal consumption	IV,	159
Cocks	III,	85
Coils	IV, 55,	160
Coke boilers	IV,	156
Cold-air box	III, 90; IV,	38
Cold-air ducts	IV,	92
Colonial house, details of building	II,	291
Colors	II,	265
Columns	III, 167,	189
Combination systems	IV, 43,	117
Combined hopper and trap closet	IV,	235
Combustion chamber	IV,	34
Commercial lighting	III,	360
Common bricks	III,	140
Common glass	III,	127
Common rafters	I,	145
Compasses	II, 76,	82
Compensator	III,	273
Composition	II,	277
Composition roofing	III, 179; V,	54
Compression tanks	III,	73
Concealed radiators	IV,	161
Concealed work	III,	340
Concrete	V, 31,	317
Concrete building blocks	V,	369
Concrete floors	III,	216
Concrete footings	III,	134
Concrete work	V, 81, 186,	358
Concreting cellar	III,	64
Conduction of heat	IV,	359
Conductors	III, 183; V,	54
Conduit	III, 348,	388
Conduit fittings	III,	389
Conduit work	III, 348,	388
Cone gears	II,	41
Cones	II, 117, 176,	177
Conic sections	II,	119
Conifers	I,	28

Note.—For page numbers see foot of pages.

	Vol.	Page
Constant-current system	III,	247, 298
Constant-potential system	III,	246, 301
Consulting engineers, employment of	V,	131
Continuous venting	IV,	339
Contractor	V, 141, 180, 300,	301
Contractor and owner, agreement between	V,	288
Contractor's bids	V,	199
Contractor's foreman	V, 181,	292
Contracts	V,	223
assignability of	V,	234
avoidance of	V,	235
breach of	V,	236
conditions	V,	232
consideration	V,	230
construction of	V,	233
discharge by consent	V,	237
express	V,	224
implied	V,	224
law of	V,	223
modification	V,	237
mutual consent	V,	228
parties to	V,	227
penalties and liquidated damages	V,	235
quantum meruit	V,	224
reformation of	V,	235
statute of frauds	V,	231
suretyship	V,	238
validity of	V,	226
waiver	V,	237
Contracts and specifications	V, 119–	220
formal contracts	V,	199
function of specification	V,	119
general contracts	V,	200
government contracts	V,	205
points of emphasis in specification writing	V,	126
specification writer's methods of work	V,	132
specifications for city work	V,	163
specifications for suburban work	V,	140
Controlling devices, rules for installing	III,	302
Convection of heat	IV,	360
Conventions used in mechanical drawing	II,	22
Copper roofing	III,	175
Corner beads	III,	59
Corner boards	I,	210
Corner posts	I,	86
Cornices	I,	262
Corrugated iron roofing	II, 384,	387
Corrugated iron siding	II, 384,	392
Country houses, drainage of	IV,	330
Courts in buildings	V,	397
Cow sheds, drainage of	IV,	329
Cross, definition	III,	277
Cross-feed connecting link	II,	33
Crossover	III,	287
Crown venting	IV,	339
Crowning	I,	116
Crystal plate	III,	128
Cube, isometrics of	II, 181,	184
Cupola	I,	188
Current	III, 238,	240
Curtain walls	III,	149
Cut-out	III, 245,	390
Cut stonework	III, 157; V,	26
Cycloid curve	II,	121
Cycloidal curves	II,	121
Cylinder glass	I,	424
Cylinders	II, 117, 175,	185
D		
Damages	V,	300
Damar varnish	I,	418
Damper-regulators	IV,	144
Dampers	III, 66; IV,	87
Decorative lighting	III,	360
Deep-seal trap	IV,	222
Design, theory of	II,	277
Design of dwelling	II, 281,	291
Detail drawings	II, 287; V, 179, 201,	291
Development of surfaces	II,	174
Devices and materials for electric wiring	III,	384
circuit breakers	III,	399
fuses or cut-outs	III,	390
miscellaneous devices	III,	401
rigid conduit and conduit fittings	III,	388
rubber-covered wire	III.	385

Note.—For page numbers see foot of pages.

	Vol.	Page
Diamond tool post T bolt	II,	33
Dies	IV,	198
Dimension lines	II,	17
Dining room	II,	283
Direct current	III,	238
Direct-current motors, wiring for	III,	267
Direct-draft furnace	IV,	31
Direct hot-water heating	IV, 14,	107
air-valves	IV,	119
air-venting	IV,	115
combination systems	IV,	117
efficiency of radiators	IV,	110
expansion tank	IV,	113
fittings	IV,	120
overhead distribution	IV,	113
pipe connections	IV,	115
pipe sizes	IV,	120
systems of circulation	IV,	108
systems of piping	IV,	111
types of radiating surface	IV,	109
valves and fittings	IV,	119
Direct-indirect radiation, computing	IV,	180
Direct-indirect radiators	IV, 14, 101,	164
Direct radiation, computing	IV, 178,	211
Direct radiators	IV,	160
Direct steam heating	IV, 12,	52
air-valves	IV,	68
boiler connections	IV,	77
blow-off tanks	IV,	78
cast-iron radiators	IV,	53
circulation coils	IV,	55
efficiency of radiators	IV,	57
expansion of pipes	IV,	66
location of radiators	IV,	59
one-pipe circuit system	IV,	64
one-pipe relief system	IV,	62
pipe radiators	IV,	55
pipe sizes	IV,	70
radiator connections	IV,	65
returns	IV,	76
systems of piping	IV,	59
types of radiating surface	IV,	53
valves	IV,	68
Direct water supply	IV,	299
Direct water supply system	IV,	282
Dividers	II,	78
Dog-legged stair	I,	290
Domes	I,	191
Domestic hot-water supply	IV, 359–	390
character of water	IV,	360
heat transmission	IV,	359
heaters and boilers	IV,	363
systems of supply	IV,	365
Door butts	IV,	402
Door checks and springs	IV,	427
Door-holder	IV,	428
Door knobs	IV,	416
Doors	III, 111; V,	412
Dormer windows	I,	224
Double-boiler system	IV,	370
Double-pitch skylight	II,	344
Double tenon joint	I,	63
Dovetailing	I,	78
Down-feed worm	II,	43
Down-feed worm wheel	II,	28
Drafting, "don'ts" in	II,	91
Drainage pipe	IV, 319; V,	33
Drainage systems, design and construction of	IV,	317
Drainage of various buildings	IV,	325
basements	IV,	325
country houses	IV,	330
cow sheds	IV,	329
garages	IV,	329
stables	IV,	328
Drainage work and venting	IV, 317–	357
design and construction of drainage systems	IV,	317
drainage of various buildings	IV,	325
Fiat system of plumbing	IV,	351
laying of drains	IV,	320
methods of testing drains	IV,	332
methods of venting	IV,	338
reports of inspection	IV,	334
roughing in	IV,	346
venting	IV,	335
Draining mains and risers	IV,	169
Drains	III, 23; IV, 320, 332; V,	77
laying of	IV,	320
methods of testing	IV,	332
Drawing-in bolt	II,	36

Note.—For page numbers see foot of pages.

	Vol.	Page
Drawing instruments and materials	II,	67, 88, 213
Drawing sheet sizes	II,	18
Drawings	II, 270, 287; V,	142, 163, 179, 201, 291
Dwelling		
design of	II,	281
practical example	II,	291
stages in building	II,	285
Drills	IV,	201
Drinking fountains	IV,	253
Drum pin radiator	IV,	124
Dry return system	IV,	166
Dry rot	I,	20
Dry wells	III,	26
Dryers used in paints	I,	407
Ducts	IV,	181, 212
Durham system of plumbing	IV,	348

E

Earth loads	V,	322
Eaves, finish at	I,	213
Electric conduits	III,	224, 348, 388
Electric gas lighters	III,	406
Electric heaters	III,	311
Electric heating devices	III,	405
Electric installations, essential parts of	III,	251
Electric lighting fixtures	V,	106
Electric signs	III,	362
Electric wiring	III,	52, 278, 293, 327, 376; V, 105, 177, 410
Electric work	V,	66
bells	V,	67
switches	V,	67
wiring	V,	66
Electrical ideas and terms	III,	238
Electricity as cause of fires	III,	237
Electrolysis	III,	283
Elevations	II,	225, 253, 269, 292, 301, 305
Elevators	V,	410
Ellipse	II,	119, 171
Emergency lights	III,	364
Employer's liability insurance	V,	181
Enamel paints	I,	422
Enameled bricks	III,	141
Enclosed wiring	III,	328
End shield	II,	47
Epicycloid curve	II,	122
Erasers	II,	'70, 213
Escutcheons	IV,	416
Estimate for suburban dwelling	V,	69
brickwork and flue linings	V,	77
carpenter work	V,	83
concreting	V,	81
electric wiring	V,	105
heating	V,	101
painting	V,	108
plastering	V,	81
plumbing	V,	103
Estimates, compilation of	V,	23
Estimating	V,	11–117
arithmetical principles	V,	17
brickwork	V,	29
carpentry	V,	34
concrete	V,	31
electric work	V,	66
excavation	V,	24
gas fitting	V,	66
general factors in	V,	12
hardware	V,	48
heating	V,	59
introduction	V,	11
lathing and plastering	V,	54
methods of	V,	13
painting	V,	56
plumbing	V,	63
roofing	V,	52
scale of wages	V,	23
stairs	V,	46
stonework	V,	26
typical estimate for suburban dwelling	V,	69
Estimating by cubing	V,	14
Estimating by quantities	V,	15
Estimating by the square	V,	15
Estimating by units of accommodation	V,	15
Excavation	V,	24, 72, 142, 183, 324
Exhaust head	IV,	140
Exhaust steam	IV,	15
Exhaust-steam heating	IV,	134, 182
automatic return-pumps	IV,	140

Note.—For page numbers see foot of pages.

	Vol.	Page
Exhaust-steam heating (continued)		
back-pressure valve	IV,	138
damper-regulators	IV,	144
exhaust head	IV,	140
grease extractor	IV,	137
pipe connections	IV,	145
reducing valves	IV,	136
return traps	IV,	142
Exhibition drawings	II,	270
Exits	V, 384, 390,	396
Expansion	IV,	175
Expansion tank	IV,	113
Expansion-tank connections	IV,	209
Expansion of water	IV,	360
Express contracts	V,	224
Exterior finish	V,	44
Exterior painting and staining	I, 412; III,	120
Exterior plastering	I, 394; III,	62
F		
F. and W. venting	IV,	342
Face bricks	III,	140
Face gear	II,	42
Factors of safety	V,	321
Faucets	V,	195
Fees	V,	311
Flat system of plumbing	IV,	351
adapted to big work	IV,	351
advantages	IV,	351
avoiding stoppage of pipes	IV,	353
bathtub connections	IV,	356
form of closet	IV,	354
lavatory fitting	IV,	354
re-vent fitting	IV,	357
sink waste pipe	IV,	356
Field punching	II,	50
Fillers used in painting	I,	410
Filleted splice	I,	71
Finish	I, 205; V, 43,	191
material used for	I,	205
outside roof finish	I,	213
outside wall finish	I,	205
trim	I,	258
window and door finish	I,	231
Finish coat	I,	386
Finish lines	II,	20
Fink truss	I,	183
Fire appliances	V,	414
Fire escapes	V,	414
Fire insurance	V,	294
Fire limits	V, 8,	314
Fire protection in reinforced concrete construction	V,	366
Fire-resisting roofings	III,	56
Fire stops	III,	47
Fireplace details	II,	327
Fireplaces	III, 65; V,	342
Firepot	IV,	33
Fireproof building	III,	211
building site	III,	212
final building operations	III,	227
final inspection	III,	231
floor construction	III,	213
general construction problems	III,	212
heating, lighting, and plumbing	III,	223
height of buildings	III,	211
land values	III,	211
partitions	III,	220
roof and wall construction	III,	219
Fireproof construction	V, 349, 365,	414
Fireproof vaults	III,	205
First-angle projection	II, 58,	143
First-floor plans	II, 296,	307
Fittings	IV, 120,	192
Fixture wiring	III, 314,	387
Fixtures	III, 314; V, 194,	402
Flashers	III,	363
Flashings	III, 55; IV,	337
Flask trap	IV,	224
Flat extension skylight	II,	344
Flat-seam roofing	III,	369
Flexible cords	III,	319
Floor finishing	I,	422
Floor framing	III,	187
Floor paper	III,	118
Floor timbers, crowning of	III,	193
Flooring	III, 36, 118,	196
Floors	I, 103; III, 36, 118,	196
bridging	I,	116

Note.—For page numbers see foot of pages.

	Vol.	Page
Floors (continued)		
composition and linoleum	III,	119, 200
crowning	I,	116
girders	I,	103
headers and trimmers	I,	111
joist connection	I,	111
joists	I,	108
porch floors	I,	117
stairs	I,	118
supports and partitions	I,	108
tiling	III,	198
unsupported corners	I,	118
wood-block floors	III,	202
wooden	III,	196
Flue linings	V,	32, 77
Flue velocities	V,	181, 213
Flues	IV, 125, 181, 212; V,	342
Flush valves	III,	78
Flushometers	III, 78; IV,	245
Foot baths	IV,	232
Footings	V,	325
Footlights	III,	366
Forced blast	IV,	16
Forced circulation	IV,	211
Forced hot-water circulation	IV,	127
Formal contracts	V,	199
Foundation walls	III,	135
Foundations	III, 131; V,	325
Frame buildings	V,	345
Frame construction	III,	11
Framing	I, 57, 159; III, 34, 37; V,	37, 190
bridging	III,	36
details	III,	48
exterior	III,	37
flooring	III,	36
girders	III,	35
joints	I,	57
partitions	III,	42
roofs	III,	41
sheet-metal joists and beams	III,	43
special	I,	159
splices	I,	64
Framing of front and side elevations	II,	313
French burl	I,	41
Front elevation	II, 301, 305,	313
Frost-proof closets	IV,	239
Fuller cock	III,	87
Furnace	III, 89; IV, 11, 30; V,	337
Furnace heating	IV,	29
chimney flues	IV,	38
cold-air box	IV,	38
combination systems	IV,	43
combustion chamber	IV,	34
efficiency	IV,	35
firepot	IV,	33
grates	IV,	32
heating capacity	IV,	36
heating surface	IV,	35
location of furnace	IV,	37
radiator	IV,	34
register	IV,	43
return duct	IV,	39
smoke pipes	IV,	37
types of furnaces	IV,	30
warm-air pipes	IV,	40
Furnace pipes	III,	49
Furring walls	I,	96
Fuses	III, 305,	390

G

Gable finish	I,	228
Gable roof	I,	123
Gaged arch	III,	153
Gained joint	I,	61
Galleries	I,	174
Gambrel roof	I, 124, 140,	227
Garages, drainage of	IV,	329
Gas fitting	V, 66, 160,	194
Gas heaters	IV,	384
Gas mains	V,	394
Gas pipes	III, 50, 224; V,	197
Gas stoves	V,	339
Geared mechanism for loom	II,	57
Gears used on 12-inch merchant mill	II,	51
General conditions of contract	V,	278, 289
General contracts	V,	200
agreement between owner and builder	V,	201
alterations in work	V,	200

Note.—For page numbers see foot of pages.

	Vol.	Page
General contracts (continued)		
architect's monthly reports	V,	203
contracts that require bonds	V,	204
prompt preparation of detail drawings	V,	201
Generators	III, 251,	255
Geometrical definitions	II,	109
Geometrical problems	II,	123
Geometrical stairways and handrailing	I,	307
bevels to square the wreaths	I,	324
curves on face-mould	I,	332
projection	I,	308
risers around well-hole	I,	338
tangent system	I,	308
wreaths	I,	307
Girders	I, 103, 169; III, 35,	191
Girts	I,	87
Glazing	I, 424; III, 127; V, 155,	193
Globe valve	II,	40
Government contracts	V,	205
building conditions	V,	207
specimen	V,	212
Grading	V,	142
Grain of wood	I,	17
Granite	V, 26, 28, 29, 185,	188
Grate surface and heating capacity	IV,	159
Grates	IV, 32,	153
Gravity circulation	IV,	108
Gravity supply system	IV,	369
Grease extractor	IV,	137
Grille work	III,	203
Groins	I,	198
Ground	III,	245
Ground detectors	III,	264
Ground line	II,	148
Ground location	I,	51
Grounding of circuits	III,	287
Guaranty bonds	V,	295
Gutters	III, 182; V,	54

H

Hair	I,	374
Hallway	II,	281
Halved joint	I,	63
mmers	IV,	202
Hangers	IV,	193
Hard water	IV,	361
Hardware	III, 112; IV, 393–451; V, 48, 95,	191
catalogues	IV,	441
finishes of	IV,	433
hinges and butts	IV,	399
knobs and escutcheons	IV,	416
locks	IV,	409
miscellaneous	IV,	424
nails and screws	IV,	396
sash	IV,	420
selecting and buying	IV,	435
Hardware finishes	IV,	433
Head of water	IV,	278
Headers and trimmers	I,	111
Heartshake	I,	19
Heat loss from buildings	IV,	23
Heat transmission	IV,	359
Heater connections	IV,	206
Heaters	III, 99; IV, 82, 104, 202,	363
efficiency of	IV,	84
types of	IV, 82,	104
Heating	III, 87; IV, 13, 81, 123, 202; V, 59, 101, 117, 156, 197,	401
Heating accessories	III,	100
Heating apparatus	V,	336
Heating capacity	IV, 36,	159
Heating devices, electric	III,	405
Heating pipes	III,	225
Heating surface	IV,	35
Heating systems	III, 87,	225
Heating and ventilation	IV, 11–149	
care and management of hot-water heaters	IV,	126
care and management of steam-heating boilers	IV,	102
direct hot-water heating	IV,	107
direct steam heating	IV,	52
exhaust-steam heating	IV,	134
forced hot-water circulation	IV,	127
furnace heating	IV,	29
heat loss from buildings	IV,	23
hot-water heaters	IV,	104

—For page numbers see foot of pages.

	Vol.	Page
Heating and ventilation (continued)		
indirect-steam heating	IV,	81
principles of ventilation	IV,	17
steam boilers	IV,	46
systems of warming	IV,	11
High- and extra high-potential systems	III,	373
High-pressure steam boilers	V,	408
High-tension lines	III,	285
Hinges	III, 113; IV,	399
Hip rafters curved	I,	155
Hip roof	I,	125
Hipped skylight	II, 344, 345,	346
Hips	III,	54
Hoistways	V,	410
Hollow walls	III,	150
Horizontal boilers	IV,	375
Horizontal center line	II,	15
Hot-air flues	V,	340
Hot-air heating	III, 89; IV, 15, 123; V,	59
rules for installation	V,	62
Hot-water fitting (see "Steam and Hot-Water Fitting")	IV,	151
Hot-water heaters	IV,	104
care and management of	IV,	126
direct hot-water heating	IV,	107
forced hot-water circulation	IV,	127
indirect hot-water heating	IV,	123
Hot-water heating	III, 96; IV, 202; V,	62
capacity of heaters	IV,	203
computing radiation	IV,	211
ducts and flues	IV,	212
heaters	IV,	202
piping	IV,	206
radiators and valves	IV,	204
Hot-water piping	IV,	206
Hot-water supply	III, 71; IV,	365
system of	IV,	365
House drain	IV,	317
House painting	I,	411
House sewer	IV,	317
House tanks	IV,	289
Housed strings, definition of	I,	271
Hydrant	IV,	295
Hydraulic water lifts	IV,	290
Hyperbola	II,	120
Hypocycloid curve	II,	122
I		
Implied contracts	V,	224
Inactive loads	V,	323
Inclined floors	I,	165
India ink	II,	80
Indirect-draft furnace	IV,	31
Indirect hot-water heating	IV, 15,	123
Indirect radiation, computing	IV, 180,	211
Indirect radiators	IV,	164
Indirect steam heating	III, 95; IV, 13,	81
cold-air ducts	IV,	92
dampers	IV,	87
direct-indirect radiators	IV,	101
efficiency of heaters	IV,	84
pipe connections	IV,	99
pipe sizes	IV,	100
registers	IV,	97
stacks and casings	IV,	87
types of heaters	IV,	82
vent flues	IV,	93
Indirect water supply system	IV,	282
Inking drawing	II, 84,	244
Inner fire limits	V,	314
Inserts	III,	152
Inside electrical work	III,	292
fixtures and fixture wiring	III,	314
installation rules for controlling protective devices	III,	302
transformers	III,	324
wiring systems	III,	293
Inside finish	III, 101; V,	43
Insolvency	V,	245
Inspection, reports of	IV,	334
Instantaneous heaters	III,	73
Instruments and materials, drawing	II, 67, 88,	213
board	II, 68,	214
bow pen and pencil	II,	79
compasses	II, 76,	82
dividers	II,	78

Note.—For page numbers see foot of pages.

	Vol.	Page
Instruments and materials, drawing (continued)		
erasers	II,	70, 213
ink	II,	80
irregular curve	II,	82
paper	II,	67, 215
pen	II,	79
pencils	II,	69, 213
protractor	II,	81
scales	II,	81, 216
T-square	II,	70, 215
thumb tacks	II,	69
tracing cloth	II,	216
triangles	II,	72, 215
Insulating joint	III,	315
Insulation, special	III,	387
Insulation for conduit and armored circuits	III,	388
Insulators	III,	241
Interior painting and staining	I, 411; III,	123
Interior plastering	I,	369, 382
back	I,	389
finish coat	I,	386
lathing	I,	370
materials	I,	373
moulding	I,	393
patent plasters	I,	389
plaster cracks	I,	389
rough plaster finish	I,	384
three-coat work	I,	382
two-coat work	I,	385
Intermediate shaft clutch	II,	30
Intermediate studding	I,	94
Intersections	II,	22, 166
Involute curves	II,	122
Iron columns	III,	190
Iron cupola chimneys	V,	344
Iron pipes	III,	68
Iron sinks	III,	85
Irregular curve	II,	80
Irregular surfaces	II,	22
Isometric projection	II,	181
applications of	II,	184
characteristics of various isometrics	II,	184

Note.—For page numbers see foot of pages.

	Vol.	Page
J		
Jack rafters	I,	153
Jambs	III,	166
Jet-siphon closet	IV,	237
Jetector wall closet	IV,	238
Joints		
in carpentry	I,	58
in joinery	I,	73
in masonry	III,	146
in plumbing	IV,	305
Joist connection	I,	111
Joists	I,	108
K		
Key-pattern air-valves	IV,	205
Kick plates	IV,	429
King-post truss	I,	180
Kitchen	II,	283, 317
Knee shaft clutch	II,	37
Knife switches	III,	303, 395
Knobs	III,	115; IV, 416
Knots	I,	21
L		
Labor, cost of	V,	23, 44, 66
Large work, methods of showing	II,	19
Lathing	I, 370, 396; III,	59; V, 54, 146, 192
Laundry tubs	III,	85; IV, 269
Lavatories	III,	78, 226; IV, 255
Law of agency	V,	238
agent	V,	239
corporations	V,	242
delegation of powers by agent	V,	241
duties of agent to principal	V,	240
independent contractor	V,	239
liability of principal	V,	240
powers of agent	V,	239
public officers	V,	242
societies	V,	242
undisclosed principal	V,	241
Law and equity	V,	243
Lead pipes	III,	67
Lean-to roof	I,	122
Ledger board	I,	88

	Vol. Page
Legal proceedings	V, 244
Legal relations	V, 223–276
architect's duties	V, 247
architect's position under building contract	V, 249
bankruptcy and insolvency	V, 245
contracts	V, 223
law of agency	V, 238
law and equity	V, 243
legal proceedings	V, 244
liens	V, 245
statute law	V, 246
torts	V, 246
Lettering	II, 83, 196
Liability insurance	V, 294
Licenses	V, 311
Liens	V, 245, 297
Light courts	V, 397
Lighting	V, 401
Lightning arresters	III, 262
Lights	
location of	V, 394
protection of	V, 395
in public hallways	V, 399
Lights and shadows	II, 237
Lime	I, 373; III, 142; V, 316
Lime deposit, avoiding	IV, 385
Limestone	V, 27, 28
Line drawing	II, 221
Line shading	II, 20, 194
Lines	II, 16, 20, 109, 155
dimensions	II, 17
finish	II, 20
section	II, 18
shade	II, 20
working	II, 16
Linoleum	III, 119
Linseed oil	I, 405
Lintels	III, 166
Liquidated damages	V, 235
Live loads	V, 323
Living rooms	II, 282
Loads	V, 322
Local venting	IV, 343
Locks	III, 114; V, 409
Loop venting	IV, 338
Lumber	V, 174, 189
Lumber prices	V, 36
Lump-sum method of determining profit	V, 12

M

	Vol. Page
Mahogany	I, 40
Mail chutes	III, 209
Main for circuit system, size of	IV, 166
Main soil pipe	IV, 335
Main soil vent	IV, 335
Main vent	IV, 335
Mains, size of	IV, 128
Mansard roof	I, 124, 141
Marble	V, 28
Marine work, electrical	III, 407
Mason work	III, 44
Masonry work	V, 29, 32, 184
Masons' supplies	V, 32
Materials, electrical (see "Devices and Materials")	III, 384
Materials for building	V, 141, 165, 180, 181, 316, 421
acceptance and rejection	V, 180
brick and stone	V, 316
cement	V, 170
concrete	V, 317
lumber	V, 174
not covered by code	V, 421
roofing material	V, 175
samples	V, 181
sand	V, 166
structural iron and steel	V, 318
tests of	V, 315
wood	V, 318
Measured work	II, 273
Measurement, units of	V, 17
Mechanical drawing	II, 67–211
geometrical definitions	II, 109
geometrical problems	II, 123
instruments and materials	II, 67
lettering	II, 83, 196
line problems	II, 92
projections	II, 141
Mechanical seal traps	IV, 221, 225
Medicine cabinets	III, 83

Note.—For page numbers see foot of pages.

	Vol.	Page
Mercury seal vacuum steam-heating systems	IV,	188
Metal lath partitions	III,	221
Metal lathing	III, 61,	221
Metal roofs	II, 360, 364; V,	54
Metal work	III, 182; V,	147
Mill construction	V,	348
Miscellaneous mechanisms for loom	II,	58
Miter coil	IV, 56,	163
Miters	I,	73
Modeling architectural drawing	II,	234
Moduli of elasticity, adhesion, bond	V,	358
Moments of external forces	V,	360
Mortar	I, 379; III, 29, 141; V,	317
Mortise-and-tenon joint	I,	60
Motor coupling of rod mill drive	II,	54
Motor starters	III,	272
Motors	III,	265
Moving-picture theaters and machines	III, 369; V,	396
Mullioned windows and casements	I, 246; III,	109
Multiple connection	III,	243

N

Nailing surfaces	I,	93
Nails	I, 49; III, 56; IV, 396; V,	49
National Electrical Code	III, 253; V,	410
Natural cement	III,	143
Niches	I,	198
Nitrogen	IV,	17
No-voltage release	III,	273
Non-conducting coverings	IV,	160
Non-enclosed wiring	III,	328
Notched strings, definition of	I,	272

O

Objects		
representation of	II,	157
rotating and inclining of	II,	158
Oblique projection	II, 191,	232
Odontoidal curves	II,	121
Office building construction	II, 290; III,	203
Offset valves	IV,	68
Ohm's law	III,	241
One-pipe circuit system	IV,	64
One-pipe heating system	IV,	169
One-pipe relief system	IV,	62
Open-grain woods	I,	418
Open-link fuses	III,	390
Open-newel stairs	I,	296
Open strings, definition of	I,	271
Open-tank vs. pressure system	IV,	210
Open timber trusses	I,	183
hammer beam	I,	185
scissors	I,	184
Open work	III,	329
Ornament	II,	280
Orthographic projection	II,	141
definitions	II,	141
development of surfaces	II,	174
ground line	II,	148
intersections	II,	166
practical problems	II, 151, 163,	168
projection lines	II,	148
projection methods	II,	144
representation of objects	II,	157
rotating and inclining of objects	II,	158
rules of projection	II,	149
true length of lines	II,	155
Outer fire limits	V,	314
Outline lighting	III,	361
Outline specifications	V,	178
Outside finish	III,	53
Outside work	III,	277
electrolysis	III,	283
grounding of circuits	III,	287
high-tension lines	III,	285
mounting of transformers	III,	287
wiring	III,	278
Overhead distribution	IV,	113
Overhead feed system	IV, 167,	208
Owner and contractor, agreement between	V,	288
Owner's rights	V, 124,	299
Oxygen	IV,	17

P

Painters' supplies	I,	405
Painting	I, 403; III, 120; V, 56, 108, 154,	193

Note.—For page numbers see foot of pages.

	Vol.	Page
Painting (continued)		
aluminum and bronze paints	I,	424
enamel paints	I,	422
floor finishing	I,	422
glazing	I,	424
house	I,	411
introductory	I,	403
painters' supplies	I,	405
structural metal	I,	415
varnish	I, 417,	422
Panel boards	III,	401
Parabola	II, 120,	173
Partition blocks	III,	220
Partitions I, 96; III, 42, 220; V, 328,		388
Party walls	III,	131
Patent plasters	I,	389
Pedestal fixtures	III,	79
Penalties	V, 235,	311
Pendant switches	III,	397
Percentage method of determining profit	V,	12
Permits V, 298, 338, 347,		402
Perspective drawing	II,	269
Perspective studies	II,	269
Piazza	III,	58
Piers	V,	328
Pigments	I,	405
Pile foundations	III,	133
Pipe columns	III,	191
Pipe connections IV, 99, 115, 125,		145
Pipe covering	III,	100
Pipe cutters	IV,	197
Pipe fitting, tools for	IV,	197
Pipe and fittings IV, 189; V,		64
Pipe sizes IV, 70, 100, 120, 126,		171
Pipe tongs	IV,	199
Pipe wrenches	IV,	200
Pipes		
air	V,	402
back-air	V,	404
brass	V,	406
cast-iron	V,	406
drain, erection and location	V,	408
drip or overflow	V,	404
expansion of	IV,	66
flushing	V,	404
galvanized wrought-iron	V,	407

	Vol.	Page
Pipes (continued)		
gas, installation of	V,	409
lead, restriction of	V,	406
rules for running	III,	68
size, weight, gage	V,	408
soil and waste	V,	404
vent	V,	402
ventilation	V,	402
Pipes for drainage work IV, 319, 347,		349
Pipes for water mains	IV,	287
Piping III, 66, 96; IV, 59, 111, 127; V,		195
brass	III,	67
iron	III,	68
lead	III,	67
pipes, general rules for running	III,	68
soil pipes	III,	66
waste pipes and traps	III,	68
Piping for hot-water heating	IV,	206
Pitch-board	I,	274
Pitch roof	I,	123
Pitch of roof	I,	129
Plan II, 224, 254, 269, 292,		296
Plan of building	V,	311
Plan of foundry building	II,	63
Planes	I,	46
Plaster	III,	61
Plaster board	I,	373
Plaster cracks	I,	389
Plaster materials	I,	373
Plaster moulding	I,	393
Plastered walls, painting	I,	412
Plastering I, 369–400; V, 54, 81, 146,		192
exterior	I,	394
interior	I,	369
Plate	I,	89
Plate glass I, 425; III,		127
Platform stairs	I,	290
Pliers	IV,	201
Plug fuses	III,	392
Plugs	III,	152
Plumbing II, 317; III, 66; V, 63, 103, 156, 194,		401
Plumbing fixtures III, 74; V,		65
bathtubs	III,	90
cocks	III,	85

Note.—For page numbers see foot of pages.

	Vol.	Page
Plumbing fixtures (continued)		
laundry tubs	III,	85
lavatories	III,	78
medicine cabinets	III,	83
shower baths	III,	83
sinks and trays	III,	85
supervision	III,	87
water closets	III,	74
Pneumatic siphon closet	IV,	235
Pneumatic system of water supply	IV,	292
Pointing	III,	170
Pole piece lamination	II,	51
Polygons	II,	110
Polyhedrons	II,	115
Porch	III,	58
Porch floors	I,	117
Portland cement	III, 143; V,	316, 364
Potential, difference of	III,	241
Potential starter	III,	273
Power	III,	242
Power-consuming devices	III,	251
Power stations and equipment	III,	254
generators	III,	255
ground detectors and tests	III,	264
lightning arresters	III,	262
motors	III,	265
resistance boxes or rheostats	III,	262
storage batteries	III,	275
switchboards	III,	259
transformers	III,	277
Practical problems in design	II,	277
buildings for offices	II,	290
design of dwelling	II,	281
notes on theory of design	II,	277
practical example: a colonial house	II,	291
stages in building house	II,	285
Pressure vs. open-tank system	IV,	210
Price lists, use of in estimating	V,	12
Priming coat of paint	I,	403
Principal, liability of	V,	240
Prismatic glass	III,	208
Prisms	II, 115,	176, 188
Private water supply	III,	73
Profit, determination of	V,	12
Projection lines	II,	148
Projection rules	II,	149
Projections	II, 15,	141, 275
isometric	II,	181
oblique	II,	191
orthographic	II,	141
Protective devices	III, 251,	302, 379
rules for installing	III,	302
Protective devices with motors	III,	270
Protractor	II,	81
Public buildings	V,	382
Public sewer	IV,	317
Pumps	IV, 130,	290
Push button switches	III,	397
Push plates	IV,	429
Putty coat of plaster	I,	384
Pyramids	II, 116,	178, 188
Q		
Quadrilaterals	II,	112
Quantity surveyor, duties of	V,	127
Quantum meruit	V,	224
Queen-post truss	I,	182
Quoins	III,	166
R		
Rabbeted splice	I,	71
Radiating surface	IV, 53,	109
Radiation, computing	IV, 178,	211
Radiation of heat	IV,	359
Radiator connections	IV, 177,	209
Radiators	III, 94, 98; IV,	34, 53, 83, 101, 110, 160, 204
cast-iron	IV,	53
connections	IV,	65
direct-indirect	IV,	101
efficiency of	IV, 57,	110
location of	IV,	59
pipe	IV,	55
types of	IV,	124
Rafters	I, 127,	145
common	I,	145
curved hip	I,	155
jack	I,	153
valley and hip	I,	148
Railway wires, lighting and power from	III,	373

Note.—For page numbers see foot of pages.

	Vol.	Page
Rainfall	IV,	274
Range boilers	III,	71
Range closets	IV,	247
Reamers	IV,	201
Red bricks	III,	140
Reduced scale of drawing	II,	19
Reducing valves	IV,	136
Refrigerator	II,	283
Registers	IV, 43, 97,	181
Reinforced concrete construction	V,	358
Reinforced terra cotta hollow tile	V,	368
Rendering	II, 243, 253,	266
Repainting	I,	413
Resistance	III,	241
Resistance boxes	III,	262
Return-bend coils	IV,	163
Return duct	IV,	39
Return pipes	IV,	76
Return traps	IV,	142
Re-vent	IV,	336
Revolving doors	III,	209
Rheostats	III, 262,	272
Ridge	III,	54
Ridge finish	I,	218
Rigid conduit and conduit fittings	III,	388
Rise and run, definition of	I,	267
Riser		
definition of	I,	267
expansion of	IV,	176
Roof. I, 121, 141; III, 41, 53;	V,	191
attic partitions	I,	156
fire-resisting roofings	III,	56
flashings	III,	55
frame	I,	133
nails	III,	56
paper	III,	54
pitch of roof	I,	129
rafters	I, 127,	145
ridge and hips	III,	54
shingles	III,	54
slating and tiling	III,	56
styles of	I,	122
Roof frame	I,	133
double gable roof	I,	139
Roof frame (continued)		
gambrel roof	I,	140
interior supports	I,	137
layout of plan	I,	133
mansard roof	I,	141
ridge	I,	136
Roof houses	III,	186
Roof mensuration	II,	365
Roof painting	I,	414
Roof plans	II, 301,	313
Roof truss	II,	61
Roofing II, 360; III, 172;	V, 52,	175
asbestos shingles	III,	179
composition	III,	179
copper	III,	175
corrugated iron	II,	384
flat-seam	II,	369
metal	II,	364
roof mensuration	II,	365
slate	III,	176
standing-seam	II,	397
supervision of	III,	181
tin-roofing specifications	III,	175
tin roofs	III,	172
titles	III,	178
tools	II,	365
Rosettes	III,	404
Rotary switches	III,	397
Rough plaster finish	I,	384
Rough strings, definition of	I,	271
Roughing-in	IV,	346
Rowlock arch	III,	153
Royalties	V,	298
Rubber-covered wire	III, 385,	387
Rubbings	II,	275
Rubble	V,	26
Rubble masonry	III,	161
Rubble walls	III,	136
Rural venting	IV,	345

S

Saddle adjusting lever	II,	44
Saddle nut	II,	24
Salmon bricks	III,	140
Sand I, 374; III, 141;	V, 167, 184, 316,	364
Sandstone	V,	28
Sanitary appliances	IV, 217–	271

Note.—For page numbers see foot of pages.

	Vol.	Page
Sanitary appliances (continued)		
bath fixtures	IV,	227
miscellaneous fixtures	IV,	253
traps	IV,	217
water closets	IV,	233
Sash-cord	IV,	424
Sash hardware	IV,	420
Sash-pulley	IV,	421
Satinwood	I,	41
Saws	I,	42
Scagliola	III,	228
Scale	II, 81, 216,	278
Schedules, illustrative	V,	110
School pin radiator	IV,	83
Scratch coat of plaster	I,	383
Screens	III,	117
Screws	I, 50; IV,	396
Seam-faced granite	V,	29
Seats	V,	389
Second-floor plans	II, 298,	307
Secondary circulation system	IV,	368
Section	II, 224,	254
Section lines	II,	18
Sectional boilers	IV,	49
Self-siphonage	IV,	221
Series connection	III,	244
Service pipes	IV,	296
Sewage pump, use of	IV,	327
Sewer connections	V,	184
Shade lines	II,	20
Shading, line	II,	20
Shadows	II,	234
Shaft-bearing pedestal	II,	47
Shafts, light or vent	V,	334
Sheathing	I,	205
Sheet glass	I,	424
Sheet-metal joists and beams	III,	43
Sheet-metal work	II, 335–	394
roofing	II,	360
skylight work	II,	335
Shellac	I, 417,	420
Shingles	I, 211; III, 54; V,	52
Shop drawings	V,	291
Shoring	V,	184
Short-circuit	III,	245
Short hopper	III,	74
Shower baths	III, 83; IV,	229
Shrinkage and settlement	I,	102
Shrinkage stresses	V,	362
Shunt	III,	244
Shuttle mechanism for loom	II,	56
Side elevation	II, 301,	313
Sidewalk lights	III,	207
Siding	I, 209; II, 384, 392; III,	58
Sign flashers	III,	363
Signaling systems	III,	376
Sill	I, 83; III,	34
Single-main system	IV,	206
Single picture views	II,	23
Single-pipe system	IV,	128
Single-pitch skylight	II,	343
Sinks	III, 85; IV,	263
Siphon trap	IV,	170
Siphonage	IV,	219
Site of building	V, 163,	183
Sitz bath	IV,	231
Sketch elevations	II,	269
Sketch plans	II,	269
Sketches	II, 270, 285,	291
Skirting	I,	258
Sky signs	V,	348
Skylight openings	I,	219
Skylight work	II,	335
bars, shapes of	II,	338
construction	II,	335
curbs, shapes of	II,	339
hipped skylight	II,	346
patterns	II, 338,	346
shop tools	II,	338
styles of	II,	343
Skylights	II, 343; III, 186; V,	411
Slabs	I,	26
Slate roofing	III,	176
Slating	III, 56; V,	53
Sleeves	IV,	193
Sliding-door sheaves	IV,	430
Sliding doors	III,	230
Smell test of drain	IV,	332
Smoke flues	V,	342
Smoke-pipes	IV, 37; V,	340
Smoke test of drain	IV,	333
Snap switches	III,	397
Sockets	III, 316,	402
Soft water	IV,	361

te.—For page numbers see foot of pages.

	Vol.	Page
Soil, relation to specifications	V,	164
Soil foundation	III,	132
Soil pipes III, 66; IV, 335, 349;	V,	196
Sole	I,	98
Solid die	IV,	198
Solids	II,	115
Special baths	IV,	229
Special electric installations	III,	360
car wiring	III,	372
decorative and commercial lighting	III,	360
high- and extra high-potential systems	III,	373
lighting and power from railway wires	III,	373
moving-picture theaters and machines	III,	369
signaling systems	III,	376
theater wiring	III,	364
Specification writer, duties of	V,	125
Specifications V, 119,	142,	179
Specifications for city work	V,	163
Specifications for suburban work	V,	140
Spheres	II,	118
Spindle	II,	60
Splices in carpentry	I,	64
for bending	I,	68
for compression	I,	65
for tension	I,	67
Splices in joinery	I,	70
battened	I,	72
filleted	I,	71
plain butt	I,	70
rabbeted	I,	71
with spline	I,	70
tongued-and-grooved	I, 70,	72
Spring butts	IV,	406
Stables, drainage of	IV,	328
Stacks IV, 81,	87,	124
Stage pockets	III,	367
Stage sprinklers	V,	394
Stairbuilding	I, 265–	339
definitions of terms	I,	266
geometrical stairways and handrailing	I,	307
laying out	I,	286
Stairbuilding (continued)		
open-newel stairs	I,	296
pitch-board	I,	274
setting out stairs	I,	272
stairs with curved turns	I,	298
types of stairs	I,	305
well-hole	I,	282
Staircase details	II,	327
Staircase finish	I,	263
Stairs I, 118, 272, 290; II, 282,	327;	
III, 105; V, 46, 386,	390,	
391, 397, 412, 418,	419	
Staking out	I,	52
Standard Documents of A.I.A.	V,	277
Standing-seam roofing	II,	379
Standpipes V, 392,	414,	415
Starshake	I,	20
Statute of frauds	V,	231
Statute law	V,	246
Staved strings, definition of	I,	272
Steam boilers and connections IV, 102, 151;	V,	392
arrangement of grates	IV,	153
ash pits	IV,	156
boiler connections	IV,	156
boiler fittings or trimmings	IV,	158
boilers for soft coal	IV,	154
capacity of boilers	IV,	158
cast-iron boilers with vertical sections	IV,	152
coal consumption	IV,	159
coke boilers	IV,	156
grate surface and heating capacity	IV,	159
non-conducting coverings	IV,	160
selection of boilers	IV,	153
small cast-iron boilers	IV,	151
Steam coils	IV,	377
Steam heating III, 91; IV, 13, 81,	187; V,	62
Steam and hot-water fitting	IV, 151–	214
computing radiation	IV,	178
ducts, flues, and registers	IV,	181
exhaust-steam heating	IV,	182
expansion	IV,	175
hot-water heating	IV,	202

Note.—For page numbers see foot of pages.

	Vol.	Page
Steam and hot-water fitting (continued)		
modified systems of steam heating	IV,	187
pipe and fittings	IV,	189
steam boilers and connections	IV,	151
steam piping	IV,	166
steam pressures and temperatures	IV,	174
steam radiators and coils	IV,	160
Steam piping	IV,	166
artificial water line	IV,	170
draining mains and risers	IV,	169
dry return system	IV,	166
one-pipe system	IV,	169
overhead feed system	IV,	167
pipe sizes	IV,	171
size of main for circuit system	IV,	166
two-pipe system	IV,	169
wet return systems	IV,	167
Steam pressures and temperatures	IV,	174
Steam radiators and coils	IV,	160
concealed radiators	IV,	161
direct-indirect radiators	IV,	164
direct radiators	IV,	160
heat given off by steam radiators	IV,	165
indirect radiators	IV,	164
miter coils	IV,	163
return-bend coils	IV,	163
wall coils	IV,	162
Steel, bending and elongation of	V,	363
Steel columns	III,	190
Steel construction	V,	374
Steel girders	III,	192
Steel square	I,	341–367
as applied in roof framing	I,	347
heel cut of common rafter	I,	355
heel cut of hips and valleys	I,	356
hips	I,	355
Steeples	I,	187
Stocks and dies	IV,	198
Stone III, 158, 169; V, 185, 188, 316,		364
Stone cutting, tools used in	III,	158
Stone footings	III,	134
Stone masonry	III,	161
Stonework	V, 26, 74, 144,	184
Stove pipes	V,	340
Stoves	IV, 11; V,	338
Street pressure system	IV,	365
Stresses, calculation of	V,	322
String-board, definition of	I,	267
Structural iron	V, 318,	374
Structural metal, painting	I,	415
Structural steel	V, 318,	374
Structural steel columns	V,	363
Stucco-work	V,	55
Studding	I,	91
Subcontracts	V,	301
Supervision	V,	307
Supports and partitions	I,	108
Suretyship	V,	238
Surface switches	III, 304,	397
Surfaces	II,	110
Swinging check valve	IV,	195
Switchboards	III,	259
Switches	III, 302, 395,	397
Switches with motors	III,	270
Swivel table stud	II,	32
Symbols used in mechanical drawing	II,	21
Systems of warming	IV,	11

T

T-square	II, 70,	215
Tables		
air-flow through flues of various heights	IV,	96
air required for ventilation of various classes of buildings	IV,	20
approved spacing and marking for knife switches	III,	396
areas of circles	V,	21
board measure	V,	35
boiler, size of, for different conditions	IV,	48
brass ferrule data	V,	405
brass pipe data	V,	407
capacities of one-pipe risers	IV,	172

Note.—For page numbers see foot of pages.

Tables (continued)	Vol.	Page
capacities of two-pipe risers	IV,	173
capacity of cisterns	V,	65
carrying capacity of wires	III,	299
cast-iron pipe data	V,	407
concrete mixtures, strength of	V,	358
corrugated sheet data	II,	386
dimensions of oval pipes	IV,	42
direct radiating surface supplied by mains of different sizes and lengths of run	IV,	121
distance to screw pipes into fittings	IV,	198
efficiency of radiators, coils, etc.	IV,	57
equivalent water pressure for different heads	IV,	279
firepot dimensions	IV,	37
flow of steam in pipes under initial pressures above five pounds, factors for calculating	IV,	71
flow of steam in pipes of other lengths than 100 feet, factors for calculating	IV,	72
flow of steam in pipes of various sizes	IV,	71
foundation loads	V,	323
friction loss, discharge, and velocity of flow through clean iron pipe	IV,	280
grate area for different rates of evaporation and combustion	IV,	47
heat loss—southern exposure	IV,	24
heat loss—other than southern exposure	IV,	25
heat units emitted from radiators and coils	IV,	165
heating surface supplied by pipes of various sizes	IV,	74
indirect radiating surface supplied by pipes of various sizes	IV,	101
lead pipe data	V,	406
mains, sizes of, for various conditions	IV,	131
minimum weights of conduit for required wall thickness	III,	389
multiples to compute measurements of regular polygons	V,	23
number of changes of air required in various rooms	IV,	21
offset data	IV,	300
open-link fuse spacing	III,	391
pipe data	IV,	190
pipe sizes from boiler to main header	IV,	77
pipe sizes for radiator connections	IV,	76
quantity of air required per person	IV,	20
radiating surface supplied by pipes of various sizes	IV,	126
radiating surface supplied by steam risers	IV,	75
radiation capacities of expansion tanks	IV,	211
relative cost of heating systems	IV,	14
roofing data	II,	361
sizes of circuit mains	IV,	166
sizes of registers for different sizes of pipes	IV,	43
sizes for return, blow-off, and feed pipes	IV,	78
sizes of returns for steam pipes	IV,	76
sizes of supply connections for indirect radiators	IV,	173
sizes of vent pipes for buildings of various heights	IV,	351

Note.—For page numbers see foot of pages.

	Vol.	Page
Tables (continued)		
sizes of wires for a.c. motors	III,	269
sizes of wires for d.c. motors	III,	268
soil and waste pipe	V,	405
soldering nipple data	V,	405
supply main and gravity return data	IV,	172
temperature of steam at various pressures	IV,	174
thickness of rubber insulation	III,	386
undivided floor area, limits of	V,	398
warm-air pipe dimensions	IV,	40
weight of cast-iron pipe	IV,	348
weight of wrought-iron pipe	IV,	350
weights of oakum and lead for cast-iron pipe joints	IV,	349
Tank water supply system	IV,	282
Tanks	V,	400
Taps	IV,	201
Tees	IV,	192
Temperature regulation of hot-water supply	IV,	382
Temporary structures, permits for	V,	347
Tenon-and-tusk joint	I,	62
Terra cotta	III, 214; V,	185, 189
Terra cotta building blocks	V,	372
Terra cotta floor arches	III,	214
Tests of concrete construction	V,	356
Tests of electric wiring	III,	380
Tests of materials	V,	315
Theater wiring	III,	364
Theaters	V,	382
Theory of design	II,	277
Thermal stresses	V,	362
Thermograde steam-heating system	IV,	187
Thermostats	III,	100
Thinners used in paint	I,	406
Third-angle projection	II, 59,	142
Three-coat plaster	I,	382
Three-way switches	III,	305
Three-wire system	III,	247
Thumb tacks	II,	69
Tiling	III, 56, 178, 198; V,	54
Timber	I,	13
characteristics of	I,	41
classes of trees	I,	13
conversion into lumber	I,	24
defects in wood	I,	18
manner of growth	I,	14
varieties of trees	I,	27
wood structure	I,	16
Tin roofs	III,	172
Tinned doors and shutters	III,	185
Titles for drawings, uniform	II,	325
Tongued-and-grooved splice	I,	70
Tools for carpentry	I,	42
Tools for pipe fitting	IV,	197
Tools for stone cutting	III,	158
Top pulley bracket	II,	44
Torts	V,	246
Towers	I,	187
Tracing cloth and paper	II,	216
Transformers	III, 247, 277, 287,	324
Transom hardware	IV,	430
Transoms	I,	243
Trap ventilation	IV,	338
Traps	III, 68; IV, 170,	217
Trays	III,	85
Tread, definition of	I,	267
Trees	I,	13
Triangles	II,	111
Triangles (instrument)	II, 72,	215
Trim	I,	258
Trolley wires	III,	282
Trombone coil	IV, 55,	163
True length of lines	II,	155
Trussed partitions	I,	162
Trusses	I,	178
details	I,	185
Fink	I,	183
king-post	I,	180
open timber	I,	183
queen-post	I,	182
Tubular boilers	IV,	46
Two-coat plaster	I,	385
Two-pipe system	IV, 59, 127, 169,	207
Two-wire system	III,	247
U		
Underground wires	III,	279

Note.—For page numbers see foot of pages.

	Vol.	Page
Underwriters' requirements	III,	235–407
devices and materials	III,	384
inside work	III,	292
installation of wires in buildings	III,	327
introduction	III,	235
National Electrical Code	III,	253
outside work	III,	277
power stations and their equipment	III,	254
special installations	III,	360
testing	III,	380
Uniform contract	V,	284
Unit stresses for steel and concrete	V,	359
Unknown dimensions, determination of	V,	17
Unsupported corners	I,	118
Urinals	IV,	251
V		
Vacuum cleaner	V,	161
Vacuum-cleaning pipes	III,	52
Vacuum heating	III,	96
Vacuum valve	IV,	70
Valley-and-hip rafters	I,	148
Valley roof	I,	125
Valves	III, 99; IV,	68, 136, 194, 204
Valves and connections	III,	94
Valves and fittings	IV,	119
Vapor steam-heating system	IV,	187
Varnish	I, 417,	420, 422
brushes	I,	408
Varnishing	I, 418, 421; V,	58, 193
Vaults	I, 198; III,	138
Vehicles used in paint	I,	405
Velocity of flow through drain	IV,	320
Veneered walls	III,	151
Vent flues	IV,	93
Vent pipes	IV,	350
Ventilation (see "Heating and Ventilation")	IV,	11
heat loss by	IV,	28
horsepower	IV,	52
principles of	IV,	17
Ventilating pipe	V,	338
Ventilation pipes	III,	50
Venting	IV,	335
Verge boards	I,	230
Vertical center line	II,	15
Vertical section boilers	IV,	152
Views of objects	II, 13,	141
Vise and bench	IV,	197
Voltage	III,	240
Voltmeter method of testing	III,	381
W		
Wage scale	V,	23
Wainscoting	I,	259
Waiver of rights	V,	237
Wall board	III,	101
Wall coils	IV,	162
Wall radiators	IV,	161
Wall shingles	III,	59
Walls	I, 82; III,	56, 137, 145; V, 328, 386, 389
balloon frame	I,	82
braced frame	I,	82
braces	I,	90
building of	III,	145
clapboarding and siding	III,	58
coal chute	III,	57
corner posts	I,	86
girts	I,	87
intermediate studding	I,	94
ledger board	I,	88
nailing surfaces	I,	93
partitions	I,	96
plate	I,	89
porch and piazza	III,	58
shingles	III,	59
shrinkage and settlement	I,	102
sill	I,	83
studding	I,	91
thickness of	III,	137
window frames	III,	56
Walls and windows, heat loss through	IV,	23
Waney lumber	I,	26
Wardrobe hooks	IV,	432
Warm-air flues	IV,	91
Warm-air pipes	IV,	40
Warping	I,	22
Warranty clauses in specifications	V,	130

Note.—For page numbers see foot of pages.

	Vol.	Page
Wash, rendering in	II,	243
materials	II,	243
method	II,	244
water color hints	II,	258
Washdown closet	III, 74; IV,	238
Washout closet	III, 75; IV,	235
Washer	IV,	295
Waste pipes and traps	III, 68; IV, 335,	349
Water		
character of	IV,	360
nature and source of	IV,	273
Water closets	III, 74; IV,	233
closet tanks	IV,	241
essential features	IV,	233
flushometers	IV,	245
frost-proof	IV,	239
range closets	IV,	247
types of	IV,	233
urinals	IV,	251
Water color hints	II,	258
Water connections	V,	184
Water hammer	IV,	304
Water mains	IV,	287
Water seal, methods by which may be broken	IV,	217
Water-seal traps	IV,	221
Water supply	IV, 273–	314
approximate delivery	IV,	276
direct water supply	IV,	299
method of wiping joints	IV,	305
nature and source of water	IV,	273
Water supply for fire protection	V,	393
Water-supply system accessories	IV,	287
house tanks	IV,	289
pumps	IV,	290
service pipes	IV,	296
washer and hydrant	IV,	295
water mains	IV,	287
Water supply systems	IV,	282
Water table	I,	206
Water test of drain	IV,	333
Water-tube boilers	IV,	49
Waterproofing walls	III,	153
Well-holes	I, 282; V,	410
Wet return systems	IV,	167
Wet rot	I,	21
Wheel guard T bolt	II,	32
Wind pressure	V,	330
Window and door finish	I,	231
casement sash and frames	I,	239
door frames	I,	250
doors	I,	255
double-hung sash	I,	236
mullions	I,	246
muntins	I,	239
pulley stile	I,	233
sill	I,	235
transoms	I,	243
Window frames	II, 319; III,	56
Window pulls	IV,	420
Windows	III, 108; V, 389,	399
Windshake	I,	19
Wiping joints, method of	IV,	305
Wire nails	IV,	397
Wires in buildings, installation of	III, 293,	327
armored cable	III,	347
classification and general principles	III,	328
concealed work	III,	340
conduit work	III,	348
open wiring in damp places	III,	333
open work in dry places	III,	329
Wires in moulding	III,	337
Wiring in inside work	III,	293
Wiring in outside work	III,	278
Wiring in signaling systems	III,	376
Wood	I, 16; V,	318
Wood-block floors	III,	202
Wood columns	III,	189
Wood cornices	I,	262
Wood girders	III,	191
Work spindle slide	II,	35
Working drawings	II, 11, 286; V,	311
Working lines	II,	16
Wreaths	I,	307
Wrenches	IV,	200
Wrought-iron construction	V,	374

Y

Y branches	V,	401
Yard fountains	IV,	255

Note.—For page numbers see foot of pages.

B89080449929
B89080449929A